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THE SCIENTIFIC MONTHLY

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Noyes's College Text-Book of Chemistry

By W. A. NOYES, Professor in the University of Illinois
336 pages of text. 12mo

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The teacher of chemistry is embarrassed by the vast and ever increasing amount of knowledge at his disposal and is often tempted to present many more topics than the student can possibly remember. In trying to avoid this difficulty many facts ordinarily included in an elementary textbook have been omitted and those which are given are brought as far as possible into close logical relations.

The summary at the close of each chapter is a somewhat unusual feature of the book. It is hoped that these summaries will be found useful.

Success in the study of chemistry depends especially on the ability to learn new facts in their relation to those which have already been acquired and on the cultivation of a logical as distinguished from an arbitrary memory. The exercises at the close of each chapter and questions occasionally inserted in the text are designed to assist the student in this direction.

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DEFECTS FOUND IN DRAFTED MEN[1]

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FORMERLY MAJOR, S. C.

AND

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LT. COL., M. C., U. S. A.

I. Statement of the Problem

THE ideal population of any country is one in which all the inhabitants are physically sound, mentally competent and temperamentally controlled. Actually, the condition of any population comes far from meeting the ideal. Witness the army of doctors, the cities of hospitals, the thousands of court-houses, jails and penitentiaries. Those persons who come to the notice of such physicians and such institutions are more or less sporadically or even accidentally brought to notice. Any survey of the physical, mental and temperamental health of a large section of the population taken without selection had until recently not been made. A complete survey of the defects in the American population which would give information would be of importance for many interests. Such knowledge would be important from the standpoint of social and industrial life, since it would give some insight into the suitability of the population for the various occupations which our social organization requires.

[1] This study is based on data recorded on Form 1010 of the office of the Provost Marshal's General and Surgeon General of the Army. Acknowledgments are made to Colonel James Easby-Smith, Colonel Frank H. Wigmore and Colonel Frank R. Keefer, of the Provost Marshal General's Office. The statistics were prepared in the Section of Medical Records, Medical Department, U. S. Army, compiled under the direction of the Surgeon General, M. W. Ireland, and published with his permission. This paper is extracted from the Introduction of a larger work which is to appear shortly under the same title as a Congressional document.

It would have social-medical bearings, since it would indicate the physical and mental status of our population in different parts of the country, amid different sanitary conditions and with varying opportunities for medical and surgical treatment. It would have important military bearings since it would indicate the proportion of men available for military service of various kinds. It would have social-therapeutic bearings, since it would indicate the size and nature of the task before those who would seek to improve, by better conditions, the physical and mental standings of our population. Finally, it would have a biological and eugenical significance in so far as it would reveal the inherent failures in man to make complete adaptation to the rapidly advancing requirements of a highly artificial civilization, the constitutional limitations of the various races to meet the conditions imposed by that civilization, and the influence of military selection on the breeding stock of the next generation.

II. Method

The emergency of a great war, however, made necessary the drafting of 3,000,000 men. This included all kinds of men outside of institutions between the ages of eighteen and thirty years. Military necessity demanded that careful physical and mental examination be made of these men in order to eliminate those who would not be fit for the severe service which they would be called upon to perform. The examination was made by physicians in thousands of local boards and dozens of camps for a period of over one year. Each man was examined by one physician and in many cases by from four to twelve. These physicians were often specialists and each rendered a verdict upon the man's physical condition, and, in case a significant blemish was found, whether important enough to prevent acceptance or not, diagnosis of the defect was recorded upon the physical examination form carried by the recruit. The records thus made were sent to the office of the Surgeon General of the Army, copied upon statistical cards, and counted and tabulated. They form the basis of the present study.

The total number of men involved in the present study was about 2,500,000. Of these about 500,000 were rejected by the medical examiners of the local boards, and there are 2 lots of about 1,000,000 each who were examined at mobilization camps, September, 1917, to October, 1918. This number constitutes practically all of those rejected by local boards and about two thirds of those examined by mobilization camps, but it is repre-

sentative of all. A few men between the ages of eighteen and twenty-one are included, but the great majority are men between the ages of twenty-one and thirty years inclusive. The exact number of men examined to furnish these data can never be precisely known. By a method of approximation based upon statistics of the Provost Marshal General's office and those of the Surgeon General's office, a hypothetical number of 2,753,922 is arrived at, and this is used as the "strength," or total population, upon which ratios are calculated. In the present paper the unit of discussion is the rate of incidence of a particular defect in 1,000 men. The rate 1, therefore, when given as the rate for a defect, means that 1 man out of 1,000 was found with that defect. Since the total of the men is about 2,754,000, "1" means that there were 2,754 men found with the given defect. The rate "2" means that there were twice this number, *i.e.*, about 3,500, etc. In the present paper, rates will usually be given as integral numbers, except in the case of small ratios.

III. Results

It is proposed to consider in turn: first, the relative frequency of the main groups of defects found; secondly, the classification of men in relation to military service on the basis of these defects; and thirdly, the relation of the defects to geographical distribution, occupation and race.

1. *Total Defects Found*

In the total population examined there were found 468 men defective per 1,000 examined. That is to say, over half of the men were found to be without any physical or mental blemish significant enough to be recorded. In some of the men 2 or more defects were noted, so that in the total there are 557 defects noted per 1,000 men examined. The number would have been somewhat higher except for the fact that only one, the major defect, was, in the first million men, copied from the examination form and was used in the present statistics. The number 557 is important because it represents the sum of all of the ratios per 1,000 men examined for the 269 defects and groups of defects that were recognized.

Of the defects found, those of a mechanical sort, involving bones and joints, appendages, hands and feet, were commonest and constitute about 39 per cent., or about two fifths, of all defects. The second place is taken by defects of the sense organs, about 12 per cent.; next come the two great and nearly equally-

sized disease-groups of tuberculosis and venereal disease, which constitute together 11 per cent.; then follow the cardiovascular diseases and defects, about 10 per cent.; and those that fall into the group of defects of developmental and metabolic processes, also about 10 per cent. Of minor importance are the groups of nervous and mental defects, about 6 per cent.; diseases of the nose and throat, about 5 per cent.; those of the skin and teeth, about 3 per cent.; those of the respiratory organs (other than tuberculosis) 1 per cent.; and "others" about 3 per cent.

The defects of the mechanical group are, as stated, far and away the commonest defects found in examination for military service and they constitute the most important group from the military point of view. As stated, the group includes about two fifths of all defects and 218 out of every 1,000 men examined showed some important defect belonging to this group. Numerically the most important item in this group, and indeed in the whole list of defects found in young men, is that of weak feet, including various forms. Of these, there were over 300,000 cases noted, constituting more than half of the group of mechanical defects and giving a rate of 124 per 1,000 men examined. That is, one eighth of the men examined had weak feet. As for other mechanical defects, deformed and injured appendages were found in over 50 men per 1,000, and hernia in 40 per 1,000.

Of the group of defects of the sense organs, about half were refractive errors of the eye, and one fourth were defects and diseases of the ear, including deafness.

Tuberculosis gave a rate of 30 per 1,000, constituting over 5.4 per cent. of the defects found. Venereal diseases gave a rate of 32, nearly 5.8 per cent. of the defects.

Of the developmental and metabolic defects, the most important are: weight below the standard required for military service, under-height, curvature of the spine, goiter (both simple and exophthalmic), defective chest measurement, imperfect development of the genitalia, and cleft palate and hare lip. There were 73,000 men found to be below the military standard of weight and this group constitutes about 5 per cent. of the defects found.

Of the nervous and mental defects, mental deficiency was the most important. It was recorded by medical examiners in nearly 40,000 men, but many more than this were detected in subsequent psychological examinations.

Of diseases of the nose and throat, the most important was enlargement of the tonsils, recorded in 64,000 cases.

Finally, of defects of the skin and teeth, those of the teeth constituted the most important group, including 40,000 men.

This summary of the various groups of defects found in the American population must not be passed by without a word of warning. As was stated above nearly half of the men examined showed a defect considered worthy of remark. It may well be a matter of surprise that not more defects were detected; probably this would have been the case, had the examinations been less expeditiously conducted. Many of the defects were obviously noteworthy only from a military standpoint. From the point of view of civil life, it is no defect that the South Italian is under 60 inches tall, though this constituted a defect from a military point of view. Also many of the defects noted, including most cases of venereal disease and many of the mechanical group, were not of a grade sufficient to render the man unfit for military service. A large proportion of the mechanical defects, important as they are in a man who is to be used as part of a fighting machine, are not a serious handicap in civil life. Also many of the defects of the sense organs that were found are easily capable of correction so as to fit a man to perform his duties in civil life. Altogether it is clear that fully ninety per cent. of the defects found are not of such a nature as to interfere seriously with the man's performing services of the highest order in civil life.

From the standpoint of the Army, as stated, the defects are not equally important. Recognition of this fact led to the establishment of 5 categories by draft and military officials. There was first the so-called Class Vg, the class of men who, on account of physical defects, were rejected by local boards from any military service. These men were not sent to camp. The men received at camp were placed in one of four "Groups," denominated respectively A, B, C, D. Group A includes men who were accepted for general military service. It comprised 2 groups, those in whom was found no defect, and those in whom was found only some minor defect which did not interfere with full military duty. Group B (which became operative only during the latter part of the draft period) included registrants with a defect which would permit of general military service after a cure had been effected by operation or otherwise. Group C included registrants with such defects as would permit them to function only in a special or limited military service in a special occupation or capacity, usually clerical. Finally, group D, included men rejected on physical grounds from any

military service. The relation of certain major defects to grouping is shown graphically in Fig. 1. It appears from this figure that nervous and mental defects, including feeblemindedness, mental deficiency, paralysis, psychasthenia, constitutional

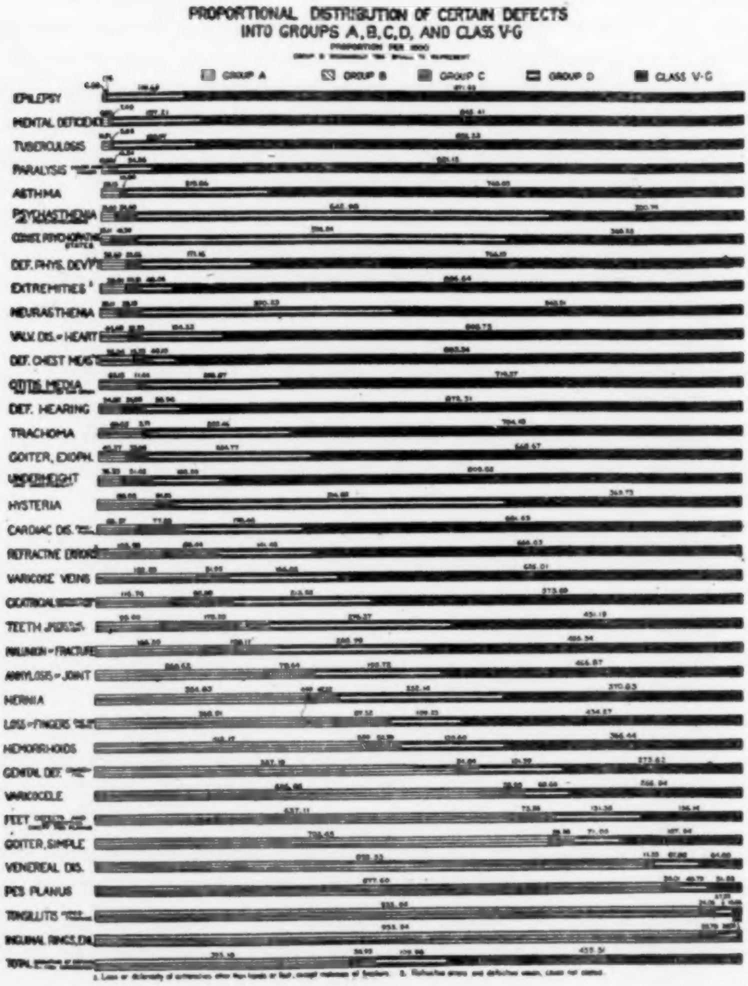


FIG. 1.

psychopathic states, and neurasthenia were among the defects, victims of which were most commonly rejected. These are the defects that are incapable of or incompatible with the strain of military training and active service. It doubtless would have been well had none of these been accepted for general military

service. It is noteworthy that certain of these conditions, like psychasthenia, constitutional psychopathic states, neurasthenia and hysteria, which are difficult to detect, were passed over by local boards and were, therefore, an exceptionally common cause for rejection at mobilization camps. On the other hand, the figure shows that relatively few men were rejected for enlarged inguinal rings (incipient rupture), for enlarged tonsils, for venereal diseases, and even for flat foot. For loss of fingers, hemorrhoids (piles) and hernia (rupture) about one half were rejected and one half accepted for general military service. Among other defects which led to nearly complete rejection were otitis media (inflammation of the middle ear due to infection), valvular diseases of the heart, asthma, paralysis, and, above all, tuberculosis. Altogether about 12 per cent. of the men examined were rejected for any military service.

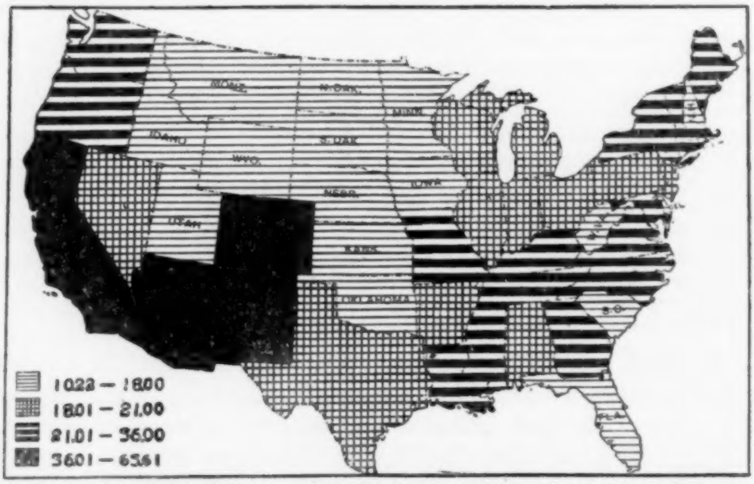
2. *Distribution of the Defects Found.*

We may now consider briefly the principal results secured concerning the geographical, occupational and racial distribution of the principal diseases and defects. The statistics for each disease have been classified by states, by sections, and by consolidated sections. A word may be said at this point about sections. It was early recognized that most of the larger states could with advantage be divided into one or more sections, depending upon geographical, occupational or racial differences. Sections having similar geographical, occupational or racial conditions were grouped in many cases and for the purpose of further study grouped or consolidated. Some of the findings of these consolidated sections are considered below toward the end of this paper.

1. *Tuberculosis.*—The facts concerning the distribution of this widespread and frequently fatal disease are shown in Fig. 2. It appears at once that the region of highest incidence of this disease is in the desert states of Arizona and New Mexico and the adjacent states of Colorado and California. The reason for this is that the described area includes so many young men who have gone there because they were already victims of active tuberculosis. Perhaps some of the tubercular men are sons of men who have migrated to these states on account of non-resistance to tuberculosis and themselves show the family diathesis. The next most infected territories are the two northernmost Pacific states, the New England states and New York, and the group of states immediately south of the Mason and Dixon

line, including also the states of Missouri, Louisiana, Mississippi and Georgia. New England has long been known as a region with a high rate of tuberculosis, a disease whose fires are fed

PULMONARY AND SUSPECTED TUBERCULOSIS



RATIO PER 1000 MEN REJECTIONS, CAMPS AND LOCAL BOARDS

FIG. 2.

by the large number of recent immigrants. The states of Virginia, North Carolina, and Kentucky contain numerous sanatoria for the tubercular. The high rate in the Gulf States is probably due to the presence in them of a large proportion of negroes, as this race, particularly the mulatto, is especially susceptible to tuberculosis. The smallest amount of tuberculosis is found in the Great Plains region and the northern part of the Rocky Mountain range. This is an area occupied largely by non-British stock, which comprises exceptionally vigorous people. Tuberculosis in the rural southern states tends to overweigh the rate of tuberculosis in the rural population of the country as a whole. But in general, the agricultural areas of the north show less tuberculosis than the urban districts.

2. *Venereal Diseases.*—These diseases have a social interest which far exceeds the military one. Their numbers give a rough index to the success that the different states have met with in their efforts to inculcate the sex mores and the capacity that the population of the different sections have in inhibiting the sex instincts. The details of distribution in different parts

of the country shown in Fig. 3 will repay careful study. This group includes syphilis, chancroid and gonococcus infections, which together give a rate of 32. This rate, or at most the rate of 56 per mille obtained from the second 1,000,000 men alone, must be taken as the most precise information we have concerning the proportion of men in the United States of the ages of eighteen to thirty, who show symptoms of venereal disease at a

TOTAL, VENEREAL DISEASES

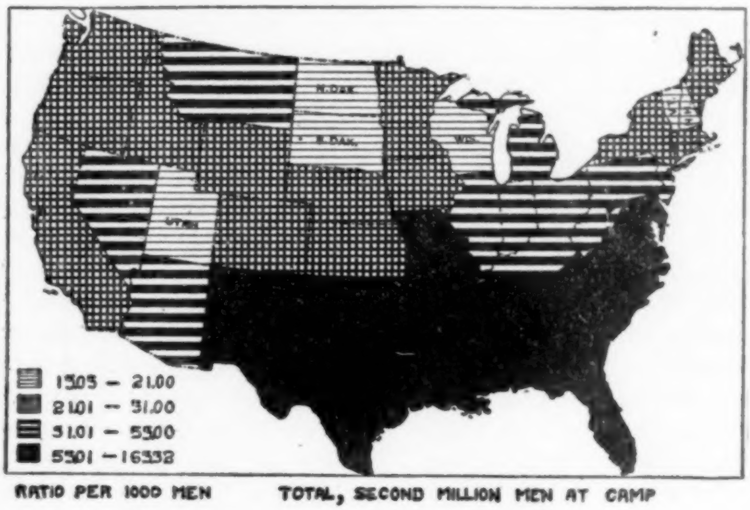


FIG. 3.

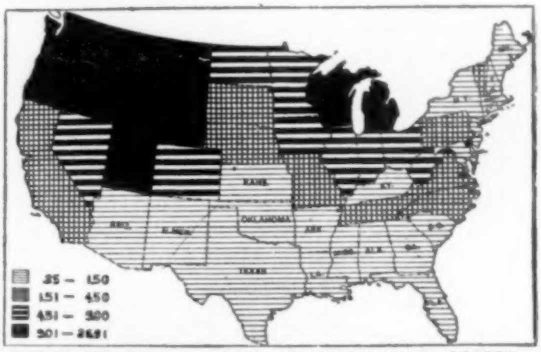
given time. There is no adequate statistical justification for the statement made by propagandists that 10 per cent., or more, of the men of the United States are affected with venereal disease. No "conservative estimate" can replace, or add anything to, the results of the exhaustive individual examination of over 2,500,000 (probably 2,754,000) men which have led to the figures just quoted. It is to be remembered, moreover, that this rate of 3, or at the maximum 5.6 per cent., includes the colored population as well as white, and there is good statistical evidence that colored men are several times as apt to be infected as white men. As the figure shows, just those states with the largest proportion of colored population have the highest ratio of venereal diseases. Adjacent regions with an intermediate proportion of colored population showed an intermediate amount. Relatively small rates were found in the New England states,

including New York, and in the northern states west of the Mississippi River. Wisconsin and the Dakotas, inhabited largely by immigrants from northern Europe, especially Scandinavia, show the lowest rate for these diseases. If the rural rate is a shade higher than the urban rate, it is because the negroes of the south unduly swell the proportion of infected states. In the northern states, like Maine, Massachusetts, New Jersey and Ohio, the rural rate is less than the urban. On the other hand, the venereal disease rate for the eastern manufacturing states, and especially for the commuter sections (rate 1.9) is less than that of the northern agricultural districts; but they are not lower than the rate in those agricultural regions which contain a large proportion of recent immigrants, especially from northwestern Europe.

3. *Goiter.*—Goiter is a disease characterized by an enlargement or a misfunctioning of the thyroid gland which occupies the lower neck region. Two types of goiter are distinguished; simple goiter, characterized primarily by enlargement of the gland, and exophthalmic goiter characterized less by enlargement of the gland than by a nervous, irritable condition, by rapid heart, and by distention of the eyeballs. It was formerly regarded as rather a rare disease in America; it was thought of as a defect which belongs to mountainous regions of Europe. One of the surprises of the draft examination is that many young men, the sex which is relatively the less affected by goiter, should be so affected. There were found over 20,000 cases, giving a rate of about 8 men per 1,000. Not less surprising is the geographical distribution of simple and exophthalmic goiter. It seems that goiter is a disease preeminently of the Great Lakes basin and of the extreme northwest. Goiter is almost absent throughout the southern states from the Cape Fear River to the Colorado. This clean-cut distribution of goiter should help in the solution of its etiology. The area of its greatest incidence in the Great Lakes region nearly coincides with that of the hard waters of the Niagara limestone. But in Oregon and Washington, where the incidence reaches the maximum, the waters are soft. However, the water of the cities of the northwest comes largely from the mountains of the Cascade Range and the Rockies, and mountainous regions are those of the highest incidence of goiter in the European countries. On the other hand, the Great Lakes region is without important mountains. Consequently the presence of lime in the water or the mountain origin of drinking water can neither of them be

considered sufficient or exclusive causes of goiter. It is believed that the distribution of goiter by occupations is subordinate to the geographical distribution. It is not because the men of

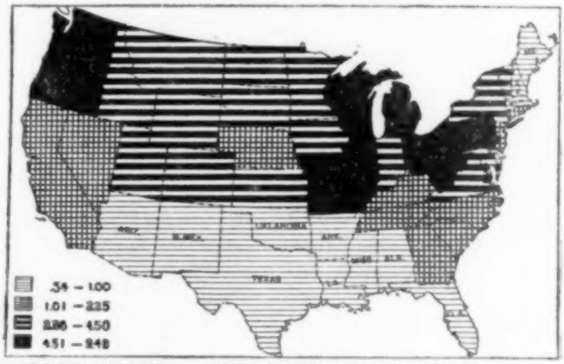
GOITRE, SIMPLE



RATIO PER 1000 MEN TOTAL, CAMPS AND LOCAL BOARDS

Fig. 4.

GOITER, EXOPHTHALMIC



RATIO PER 1000 MEN TOTAL, CAMPS AND LOCAL BOARDS

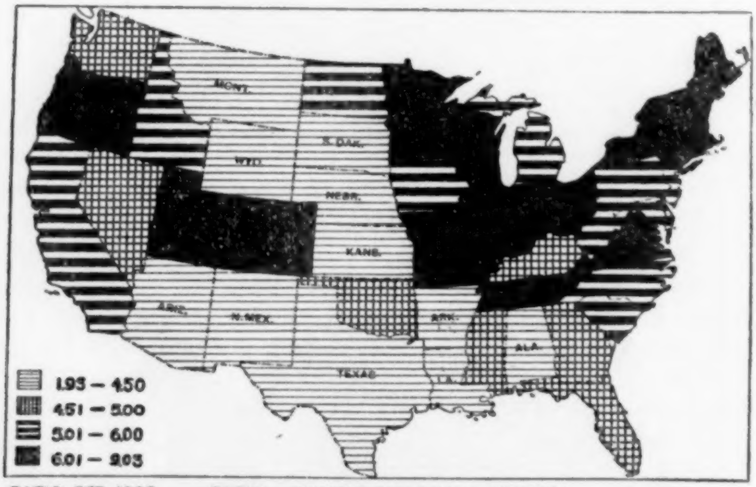
Fig. 4*a*.

Washington are largely lumbermen that they have goiter, but it is because they live in the state of Washington. On the other hand, it is not clear that race has no significance in the occurrence of goiter. For not all persons who live in goiterous regions are affected with goiter, and it is possible that there is a selection based on race of those who show the symptoms. There is an excess of goiter among the Scandinavians and the rate is higher still in those sections with a large proportion of Finns, but it must be recognized that the sections inhabited by Finns are

both in northern Michigan, a center of goiter. See Fig. 4, simple goiter, 4*a*, exophthalmic goiter.

4. *Curvature of the Spine.*—Though it can not be denied that there are hereditary factors which favor the development of spinal curvature, yet it is probable that a large proportion of the cases are developed under conditions of bad posture. However it is induced, the amount of it found was strikingly large. It occurred on the average 5.5 times in every 1,000 men examined. The map in Fig. 5 shows the distribution of curva-

CURVATURE OF SPINE



RATIO PER 1000 TOTAL, CAMPS AND LOCAL BOARDS

FIG. 5.

ture of the spine by states. It appears that New England and the densely populated states about the Great Lakes are regions of high incidence. States of the Great Plains and the Gulf show relatively little curvature of the spine. The low rate in the Gulf states is doubtless due largely to the negro population, which is one relatively little affected with curvature of the spine. In general, the great agricultural regions are less affected than the eastern manufacturing sections. There is a minimum rate in the sparsely settled sections along the Mexican border, which contain a great many Indians and Mexican-Indians. The highest rate, 7 per 1,000, is found in sections having a large proportion of French-Canadians.

5. *Defective Physical Development and Deficient Chest Measurement.*—These terms include a large range of conditions due to a variety of causes. The group is of great significance from a military standpoint, but its numbers are not very large, only about 9,700, giving a rate of about 3.6 per 1,000 men. The group has a great importance for social therapeutics since it is largely due to unhygienic methods of living, although in a considerable part it is due also to congenital defects. The distribution of these defects is shown in Figures 6, 6*a*, 6*b*. The center for defective physical development is found in the states which are grouped around Chattanooga, and it seems probable that the high rate in this territory is largely determined by the pres-

DEVELOPMENTAL DEFECTS

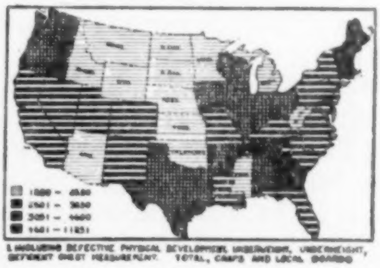


FIG. 6.

DEFECTIVE PHYSICAL DEVELOPMENT

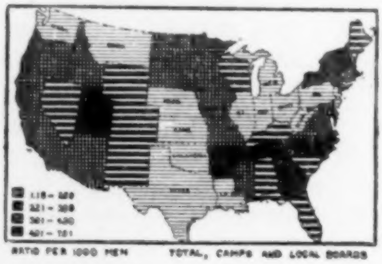


FIG. 6*a*.

DEFICIENT CHEST MEASUREMENT

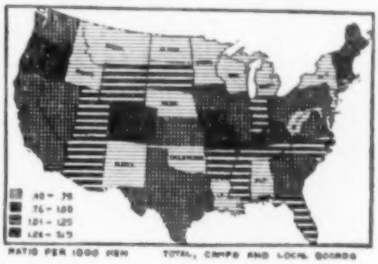


FIG. 6*b*.

ence of hookworm infection. There is another center in New England, and this seems to be controlled very largely by the French-Canadian immigrants, who show a high rate of defective physical development. There is a slight excess of defective physical development (but not of deficient chest measurement) in rural districts. This is doubtless determined by the hookworm infection among the agricultural whites of the south. In the northern states that contain large cities, there is a relatively low urban rate for "defective physical development" which

UNDERWEIGHT

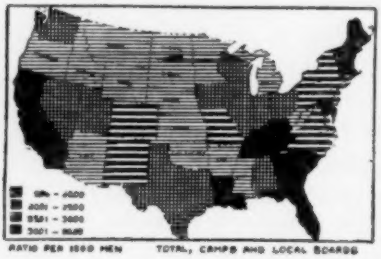


FIG. 7.

MALNUTRITION

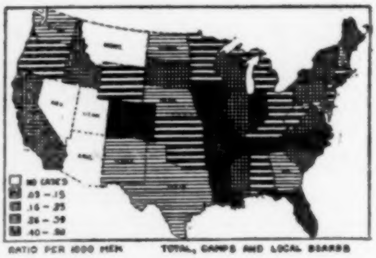


FIG. 7a.

may be due to an avoidance of this vague term by physical examiners. There is a relatively low urban rate for deficient chest measurement in rural districts of the north and this may be in part accounted for by the more varied muscular activity of the children who live in the open country.

6. *Underweight.*—The physical examination standards prescribed a minimum weight of 114 (or in certain cases 110) pounds. Many of the registrants, however, were rejected who weighed far more than the lower limit, when their weight was markedly below that of the normal man of their height. Underweight, consequently, included two groups, those who were racially small and those who suffered from malnutrition in the broad sense. Malnutrition was, of course, chiefly the result of parasitism; and altogether there were noted 73,000 men, giving a rate of 27 (Fig. 7*a*). The map in Fig. 7 shows the distribution of underweight in the different states. One obvious center is in New England. This is largely due to the recent immigration to that section of small races like the South Ialians, Portuguese, and Polish Jews. The second center, in the southeast, is chiefly due to hookworm and malaria. The underweight that characterizes the state of California is doubtless chiefly due to

UNDERHEIGHT

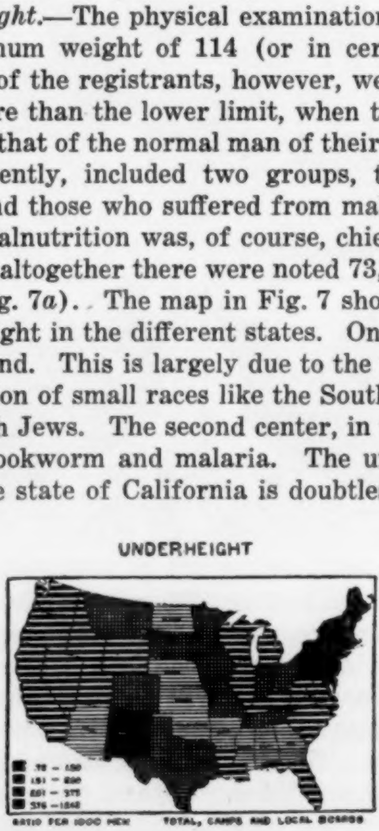


FIG. 8.

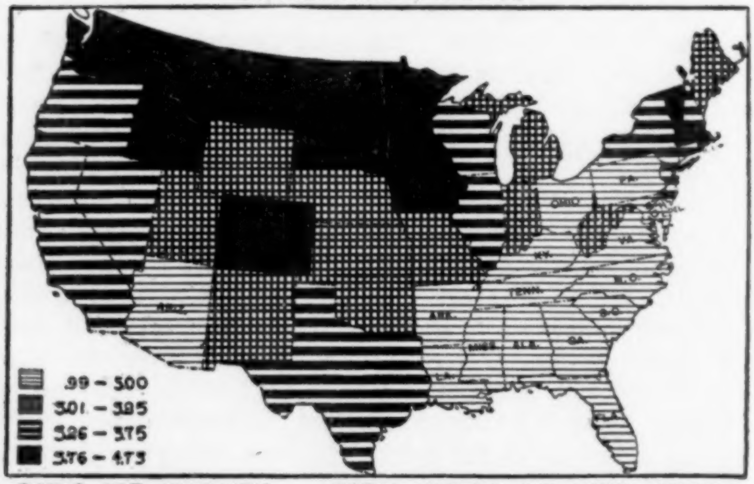
tuberculosis, but may in part be due to the presence of small races, like the Japanese. Underweight is prevailingly an urban defect, primarily because the northern cities which tend to control the statistical result are those to which the small races of South Italians and Polish Jews have largely immigrated.

7. *Underheight.*—Stature is determined primarily by racial conditions. Thus, the Scotch are the tallest people on the globe and the South Italians and Polish Jews are among the shortest people of Europe. Stature seems to be practically independent of environmental conditions and, if underheight is commoner in cities than in the country, it is not due chiefly to environmental conditions in urban districts, but to the fact that the short races prefer to live in cities, while the tall Scandinavians and Scotch are largely rural dwellers. The total amount of underheight was not as great as of underweight—only about 8,000 cases, giving a rate of 3 per 1,000 men examined. This is largely because the minimum requirement for military service was, during most of the period of the draft, retained at 60 inches, a stature a little less than the average for males of the short races that have made their home in this country. The geographical distribution of underheight is shown in Fig. 8. New England and the Middle States, the states that have received the greater part of the new immigration, show the largest proportion of presence of underheight. The rate is high on the Pacific coast also, which result may possibly be due in part to the influence of Orientals. Relatively little underheight was found in agricultural districts, especially in the south. The rate is high in the eastern manufacturing and commuter group because of the presence of short races in them. There was a rate of less than 2 in the Scandinavian sections, but a rate of over 8 in those occupied largely by French-Canadians. The condition, while not serious, is also one that can not be altered by any prophylactic measures. If there is any desire to keep down the proportion of our population who are below the stature requirement for military service, it can only be done by restricting immigration of people belonging to short races.

8. *Imperfect Sex Development.*—Of the defects of this group about 8,000 cases were found, making a rate of 3. The defects of this group, congenital in their nature, can not be altered by prophylaxis, and, though remedied by surgical operations, recur in subsequent generations by inheritance. The commonest of these defects is cryptorchidism, or failure of descent of one or both testes. The distribution of these defects is shown in Fig. 9.

This map yields the striking result that the defect predominates in the northern one or two tiers of states west of the Mississippi from Minnesota to Washington. There is also another center of incidence in southern New England. The latter is possibly due to the presence of French-Canadians, since the section in which they are most numerous have a rate for cryptorchidism of over 3. As for the states in the northwest, most of them contain considerable Scandinavian population and the Scandinavian group section also shows a rate of over 3 for cryptorchidism alone.

EXTERNAL GENITAL ORGANS
CONGENITAL DEFECTS



RATIO PER 1000 MEN TOTAL, CAMPS AND LOCAL BOARDS

FIG. 9.

In any case, the variations in the rate are to be accounted for on racial grounds. The relatively low rate throughout the south is probably influenced by the presence of negroes, in whom cryptorchidism is relatively uncommon. (?)

9. *Deformed, Atrophied or Lost Arms.*—Serious defects in the arms were found in about 15,000 cases. The loss or deformation of the arms is not only of great military, but also of great civil importance, since it limits a man's activity in industrial life. Indeed, most of the operations of manufacturing and commerce require the use of two arms. Such a defect is entirely prohibitive of military service. The distribution of loss of upper extremities by states is shown in Fig. 10. It is seen that this is common in the states bordering on the Allegheny

Mountains from Pennsylvania to Georgia. It is also found in excessive numbers in the Gulf states from Mississippi westward, and in the state of Washington. The loss of the upper extremity is determined largely by the hazard of occupation. Probably an important reason for loss of the upper extremity along the Allegheny Mountains and in the western Gulf states is

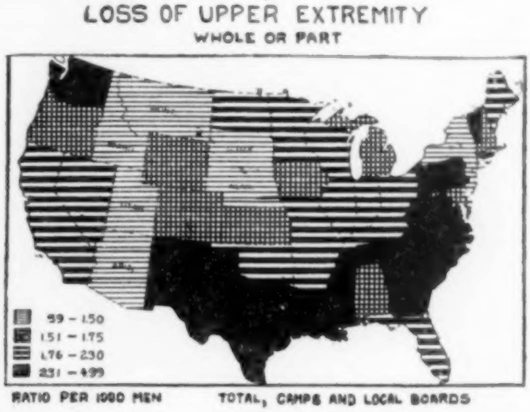


FIG. 10.

the extensive lumbering operations going on in those states, or which have gone on in them during the last ten or fifteen years. Similarly with the state of Washington, which is now the principal lumbering state of the Union. Saw-mills, planing-mills, box factories, all offer special hazards to the appendages. Also in rural communities the opportunity for the proper setting of broken bones is much less than in cities. Consequently, we find faulty union of fractures of the upper extremities relatively common in rural states. Also loss of upper extremity, deformity of upper extremity, ankylosis of joints are all much commoner in rural districts. However, the hazard of cotton mills in the south (in which there seems to have been in the past imperfect protection cf workmen) is doubtless responsible for a considerable part of urban loss of arms such as is found in southern cotton mill states and their cities.

10. *Deformed, Atrophied or Lost Legs.*—This defect is 50 per cent. commoner than the preceding defect, showing that legs are more subject to hazards that maim but do not kill than arms. The map showing the distribution of loss of lower extremity, whole or in part, is given in Fig. 11. This figure shows the relatively large incidence of loss of lower extremity in the states of Washington and Utah, and in the mining states

grouped around the head of the Ohio River, and also Virginia. There is more than the average of this defect found in the states from Louisiana northwest to Colorado, while the mining states of Idaho, Wyoming and Montana have relatively little of it. It seems probable that the loss of extremity in the different states is determined in part by lumbering operations and in part by mining. At any rate, the defect is found more predomi-

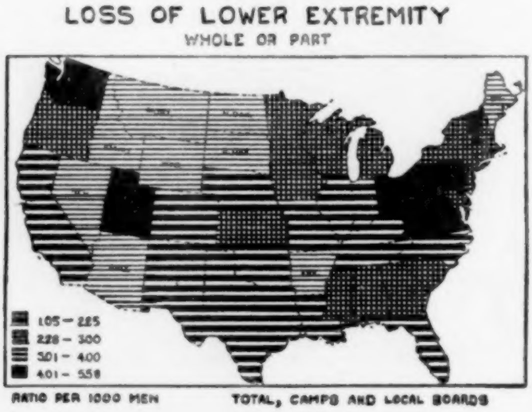


FIG. 11.

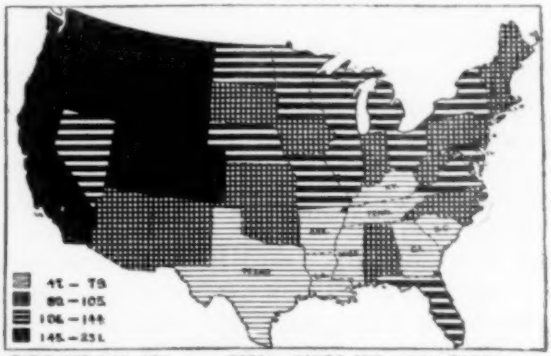
nantly in the rural regions than is loss of the upper extremity. This is probably because there is little danger to loss of lower extremity as compared with loss of upper extremity in cotton and other mills, while the hazard to the lower limbs in various agricultural pursuits is equally great to both pairs of appendages. In centers for railroad shops, like Ogden, Utah, the rate for defective legs is very high.

11. *Weak and Deformed Feet.*—As already stated, this is far and away the most important defect, numerically and from the standpoint of military service, found in drafted men. It is also of considerable economic importance in civil life, since it handicaps a man in performing duties which require standing on the feet, the very conditions which have induced it in the first place. It is to a great degree dependent upon the wearing of ill-fitting shoes and hence may be combated in the future by propaganda directed toward the reform in the shape of shoes. From the biological standpoint the important breakdown of the feet in the comparatively young male population indicates that the feet are badly adjusted to the demands made upon them in modern civilized life.

The geographical distribution of flatfoot (which controls in

this group of defects) is shown in Fig. 12. The one striking fact in the geographical distribution is comparative freedom from foot defects enjoyed by the southern states. This is due both to the comparative absence of shoes in the rural population,

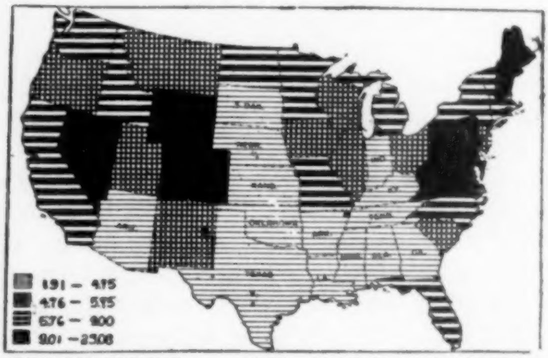
PES PLANUS
FLAT FOOT



RATIO PER 1000 MEN TOTAL, CAMPS AND LOCAL BOARDS

Fig. 12.

HAMMER-TOE AND HALLUX VALGUS



RATIO PER 1000 MEN TOTAL, CAMPS AND LOCAL BOARDS

Fig. 12*a*.

during early years of life and to the large colored population which, partly because of such freedom from shoes and partly because of anatomical and physiological peculiarities, is less affected with weak feet than whites. The great center of flatfoot is in the northwest, probably partly on account of the large body-size of immigrants into that territory. For flatfoot, among other things, is induced by the weight of the body which has to be supported. Flatfoot and particularly hammer toe and bent great toe (Fig. 12*a*) are common in the densely populated states

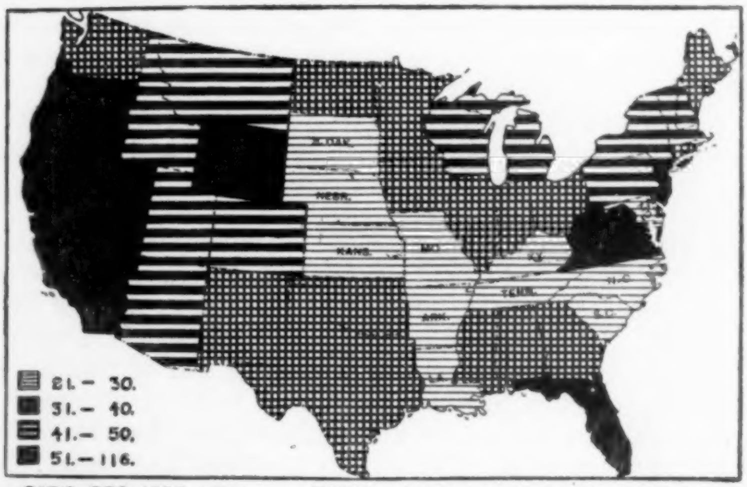
of the northeast. This is due to the presence in those states of large cities, for bad feet are above all defects of the cities, due to the conditions of life, which make it necessary to stand on the feet, to walk on hard pavements and to perform less varied occupations than the country man is expected to do. Especially in the North there is a more constant use of shoes during the earlier years of life, and of deforming and ill-fitting shoes at all times of life. The racial difference in respect to flatfoot is not striking. It is especially common among the larger races, like the Germans, Austrians, and Scandinavians.

12. *Deformity of Hand or Loss of Fingers.*—Although less important from a military point of view than weak or deformed feet, deformed or absent hand or fingers are of great importance in social life, particularly in the various industries. There were over 20,000 cases of this defect recorded, which means that nearly 8 out of every 1,000 men are defective in this respect. There are 3 principal regions of incidence: first, the New England states; second, the group around the Great Lakes; and third, the group in the northwest. As the defect is much commoner in rural than in urban districts, those states which contain great cities like New York, New Jersey, and Illinois fall below the upper third of states arranged in order of incidence. The defect mentioned is associated in part with the lumbering industry and its associated saw-mills. This is no doubt why the rate reaches a maximum in the state of Washington and why it is very high in Maine, Michigan and Wisconsin. Also it is quite clear that mining operatons are contributory and hence we find a relatively high rate in the states of Montana, Idaho, Wyoming, West Virginia, Ohio and Michigan. The rate in Pennsylvania is kept low by the presence of large cities. The region of the great southwest with treeless plains and deserts is relatively devoid of injury to or deformation of hands. The rate for finger defects is high among the Finns, but that is largely because they are engaged in mining. It is relatively low in the agricultural sections, particularly those made up of native stock.

13. *Hernia.*—The inability of the lower abdominal muscles and fascia to withstand extraordinary strain is an indication of man's imperfect adaptation to the erect position and to the demands made upon him by the severe physical strains of modern civilization. The presence of threatened or frank hernia is one of the greatest defects found in men of military age. It was detected in nearly 40 per 1,000 or 4 per cent. of them, a total of over 100,000 individuals.

The distribution of hernia and enlarged inguinal rings over the United States is shown in Fig. 13. One of the striking facts represented on this map is the great uniformity in the distribution of hernia in the different states. The range is small, varying from a maximum of 29 in Florida to a minimum of 13 in Maryland. Consequently the variations in incidence as shown on the map are apt to be influenced by such incidental matters as idiosyncrasies of examiners at the various camps. Taking the chart as it stands, it appears that there is a high rate for hernia in the Rocky Mountain states, Great Basin and the Pacific slope. Men from these states were all examined at

HERNIA AND ENLARGED INGUINAL RINGS



RATIO PER 1000 MEN TOTAL, CAMPS AND LOCAL BOARDS

FIG. 13.

Camp Lewis. On the other hand, these are largely mining states where, there is reason to suspect, the men of military age have been subjected to an unusual amount of heavy work. Similarly, we find that the rate is high in Pennsylvania and West Virginia, mining states; also in most of the New England states, Michigan and Wisconsin. Among the different races considered we find the highest rate among the French-Canadians, Germans, and Austrians, and the lowest rate among recruits of Scotch origin.

(*To be Concluded*)

THE HAVEN OF HEALTH

By GEORGE ERIC SIMPSON

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THOMAS COGAN, physician and schoolmaster of Manchester, in 1584 published a book to which he gave the modest title "The Haven of Health." At the time of the publication Queen Elizabeth had been on the throne twenty-six years. Four years later the Spanish Armada was to be ingloriously swept from the seas by a combination of British valor and unfriendly winds. Three years were still to pass before William Shakespeare would move to London. The jubilee of learning was soon to be at its full height.

Galen was still the god of biological science, whom to question was blasphemy. At this time, as for the previous fourteen centuries, his writings were considered the last word in all discussions physiological or anatomical. None might question his authority without encountering the opposition of all God-fearing folk. There had come from the pen of Vesalius some forty years previous to the writing of the "Haven" a work of anatomy, the "Fabrica Humani Corporis," which was a worthy harbinger of the new learning. Vesalius had arrived at the peculiar conclusion, probably not without many misgivings, that more might be learned by direct observation than by poring over the works of the philosophers of Greece and Rome. But even so strong-minded and purposeful man as Vesalius found it sometimes expedient to tread with meticulous discretion so that his differences with Galen should be passed over lightly, as, for example, when he was content to wonder at the power of Almighty God who was able to cause the forcing of the blood from the right to the left ventricle through the invisible pores in the thick wall separating these two cavities. But the two-score years must still pass before Harvey, in 1628, should bring out his book demonstrating the proofs of the circulation of the blood. Harvey followed in the footsteps of Vesalius in that his knowledge was gained by direct observation rather than by minute and painstaking perusal of the authorities.

The "Haven of Health" was first published in 1584 or 1586. There was a second edition, "corrected and augmented," in

1589, followed by others in 1596, 1605 and 1636. The last edition was merely a reprint of the first. The copy of Cogan's book to which the present writer has access was "Imprinted at London by Richard Field for Bonham Norton, 1596." The dedication to the "Right Honorable and my verie good Lord, Sir Edward Seymour Knight, Baron Beauchamp, and Earle of Hertford" bears the date 1588.

Cogan tended to break away from precedent by writing in English. As early as 1534 to be sure, Sir Thomas Elyot had brought out a semi-scientific book, "The Castell of Helth," in the vernacular. But so much feeling was aroused in medical circles by Elyot's presumption that it was found necessary in the preface of the later editions to set forth a defence of the innovation:

> Now when I first wrote this boke I was not all ignorant in physicke. And although I have never been at Mountpelier, Padua, nor Salern, yet have I found some thyng in physicke whereby I have taken no little profit concerning myne owne helth. . . . But if physicions be angry that I have written in englishe, let them remember that the grekes wrote in greke, the Romains in latin. . . .

Pure scientific literature continued to be written almost exclusively in Latin. Vesalius had written his book in Latin, and Harvey was to write his in the same language. Nevertheless, the "Haven of Health" exemplifies the spirit of the times. A positive statement is seldom made without marginal reference to the authority for such statement. It is a rare page that has not at least one marginal note, while many have three and sometimes four such references, so that they resemble the pages of a cross-reference Bible. Aristotle, Hippocrates and Galen are frequently referred to. For the author makes no claim for originality:

> And if they [the readers] find whole sentences taken out of Master Eliot his Castle of Health,[1] Scho. Sal.[2] or any other author whatsoever, that they will not condemne me of vaine glorie . . . for I confess that I have taken Verbatim out of others where it served for my purpose, and especially out of Scho. Salerni; but I have so interlaced it with mine owne, that (as I think) it may be better perceived. And therefore seeing all my travail tendeth to common commoditie, I trust everie man will interpret all to the best.

[1] Sir Thomas Elyot, "The Castell of Helth," London, 1534.

[2] "Regimen Sanitatis or Schola Salerni," a work on health in Latin hexameters composed by Robert, Duke of Normandy and son of William the Conqueror. The annotations to this work by various subsequent writers were of more value than the original composition. It is said to have gone through no less than 160 editions.

It is of course necessary for Cogan to explain in these prefatory remarks the form or order which he observes in assembling his material:

> Such as have written of the preservation of health before me, for the most part have followed the division of Galen into things not natural, which be fixed in number, Ayre, Meate and Drinke, Sleepe and watch, Labour and rest, emptiness and repletion, and Affections of the mind. However, Hippocrates in the sixth book of Epidemies, set down Labour, meate, Drinke, Sleepe, Venus, all in a measure, as a short summe or forme of a man's whole life touching diet.

In the disagreement of such high authorities, our author is able to exercise some choice in the "order" of his book. Such manipulations of authority are not infrequent. For instance, the "Haven of Health" is written primarily as a guide for students. This circumstance provides the author a means of brushing off some of the dusty accumulations of the ages, because Aristotle, Hippocrates, Galen and the rest did not limit their field in this way. Those things which are good for laborers may not be good for students, for we are constantly reminded that "Great labour overcometh all things," especially in the way of dietary indiscretion. Thus, "In some shires in England they use in Lent to eate raw Leekes and hony, with Beanes or Pease sodden, but what Rustickes do or may do without hinderance of their health, it is nothing to students: for Gross meate is meete for grosse men." And, furthermore, "pease potage" can not be recommended for students, but "I leave it to Rustickes who have stomacks like Ostridges, that can digest hard iron. And for the student I allow no bread but that which is made of wheat."

Although Cogan does not always hold to current views and sometimes goes out of his way to disprove them, this is never done by ready recourse to his two good eyes, but, consonant with the spirit of the times, by quotations from authority. Thus in order to prove that rabbits are not hemaphroditic he does not recommend examination of the animals themselves, but says: "The opinion which some holde, that everie hare should be of both kindes, that is male and female, is disproved by Matthiolus . . . as untrue."

The book proper opens with a discussion of the geography and physiography of the British Isles, especially as they are in contrast to the Roman world. This is evidently a bit of hocus pocus so that when our author disagrees with the older philosophers he may be able to show that the differences are more

apparent than real and are bound up in differences in climate, topography, or what not. Thus, although the Salernian school discountenances the use of beef, and Galen too, disapproves its use, saying "It maketh grosse blood and engendereth melancholie," Cogan is able to approve its use as follows: "All these authors (in mine opinion) have erred in that, they make the Biefe of all countries alike, For had they eaten of the Biefe of England, or if they had dwelt in this our climate, which through coldness doth fortifie digestion, and therefore requireth stronger nourishment."[3]

After this safety valve introduction we are justified in going on with the subject in accordance with the aforesaid schedule. First,

> When you are arisen from sleepe, to walk a little up and downe, that so the superfluity of the stomacke, guttes and liver, may the more easily descend, and the more easily be expelled. . . . Morover to extend and stretch out your handes, and feete and other limmes that the vitall spirites may come to the utter partes of the body. Also to combe your head that the pores may be opened to avoide such vapours as yet by sleepe are not consumed. Then, to rub and cleanse the teeth. For the filthiness of the teeth is noysome to the braine, to the breath, and to the stomacke.

When the "vitalle Spirites" have wandered to their proper stations, and the vapours have arisen from the head, exercise is in order, provided the oracle is favorable. The oracle consulted in this case is the color of the urine which should be neither too pale nor too red. As an example of the benefits to be procured by exercise, the case of Milo Crotoniates is brought forth. Milo was a gentleman of no mean ingenuity and initiative. For he it was, who, in the lack of Whitney exercisers, made use of available material, and by carrying a "calfe every day certain furlongs was able to cary the same being a Bull." Perhaps all the young married men of the neighborhood engaged in the pastime. Perhaps classes were formed. Perhaps in those days astute men of affairs neglected their business to carry appealing young calves, or the same being bulls, along the country lanes just as in 1919 otherwise sane men are known to spend hours at a time whacking little white balls across green fields. Who shall say that the golf widow of 1919 is not the lineal descendant of the "calfe widow" of 1594?

Further exercise suitable for the development of the various parts of the body are set forth. Tennis is stated to have been

[3] I have omitted no part of this last sentence. It is complete as quoted. It is quite usual to leave a loose end hanging over in this way, ready to drop off and endanger traffic.

recommended by Galen as an exercise proper for all parts so that "Those founders of Colleges are highly to be praised, that have erected Tenis courtes." Cogan, of course, had never heard of the dilation of the blood vessels in the walls of the intestine during digestion, but nevertheless discountenances hard exercise after meat, because, we are told, "Hastie moving driveth the natural heate from the inward parts."

That so many of the recommendations made in an empirical spirit have been supported by later scientific findings makes the book especially interesting. One is frequently surprised at the wise counsel given, only to be later amused at the seemingly absurd reason which supports the advice. However, it is yet too easy to find a physician who will explain the use of certain remedies for rheumatism as due to their ability to dissolve uric acid, the reliance on quack remedies is still too widespread, for the modern reader to assume any air of superiority over the sixteenth century writer. In reading his book, sensations are aroused akin to those provoked by correcting a set of examination papers. High hopes of deep knowledge are raised, only to be rudely dashed to the ground by the shallowness revealed in excessive loquacity.

But some of Cogan's explanations might very readily be accepted by a large group of non-scientific men to-day. In this respect I believe the average man of science has an exalted idea of ordinary "lay" opinion. Within the last month the writer heard an intelligent man, who had seven years ago graduated from one of our foremost American colleges give the reasons why lemon and milk had better not be eaten together. "The essence of lemon is citric acid, the essence of milk is malt, and of course the two do not mix." In the subsequent development of these novel views it appeared that the modern cow produced Horlick's Malted Milk, or milk that needed only to be evaporated carefully in order to yield the proprietary preparation. But to proceed—

Many of the home remedies now in use or their prototypes were known to Mrs. Crotoniates. Who, in his childhood days has not had onion concoctions inflicted on him by a well-meaning, but erring grandmother? Cogan had.

And if any be troubled with the cough, and be overlayed with abundance of fleume in the breast, so that they can not easily draw their winde, let them rost Onions under hotte embers and eate them with Hony and Pepper and Butter morning and evening, and within few dayes they shall feele their breastes loosed, and the fleume easily to be avoided.

The lowly prune is shown to have a long and a proud lineage.

> Prunes being eaten first, beside that they are pleasaunt, they loose the belly. . . . I have written the more of Prunes, because it is so common a dish at Oxford.

The unchangeableness of college boarding houses is evidently not a new thing under the sun.

In the section on labor considerable advice is given regarding study, the assumption being that this is an activity with which a student may be not unacquainted. Morning is the best time for this, as then the "planets are favourable, Sol, Venus and Mercurie being near." One should work earnestly for an hour,

> then the hair comber upwards forty times and the teeth rubbed. No new reading to be done in the afternoon, as now the sun is not convenient. But nothing is more hurtful than study at night.

Let the freshman gloat. But his gloating will be short-lived, for, our author continues,

> Good students will spare no time from their books. . . . And if they wax pale with over much study, it is no reproche, but a verie commendable signe of a good student.

As for mental recreation, the playing of gambling games is discouraged (somehow the reader obtains the idea that this advice is rather half-hearted) but chess is recommended as an easily accessible pastime which students may have available at all hours. A prime source of recreation "for a mind wearied with study and for one that is melancholie (as the most part of learned men are) is music." Aristotle is properly given credit for this bit of wisdom.

Under the caption "Meate" a great variety of edible substances, together with some of the medicinal plants are discussed and classified according to their "hotnesse or coldnesse, dryness or moistness."

> Goates flesh . . . is dispraised of Galen. Because, beside that it breedeth ill bloud it is tarte. Yet kidde is commended of him next unto pork. But Auicen and the sect of the Arabians, doe prefere kids flesh before all other flesh, because it is more temperate and breedeth pure bloud; as being in a meane betweene hote and colde, subtill and grosse. So that it can cause none inflamation nor repletion. . . . But it is not convenient for labourers because great labours would soone resolve the juice engendered thereof.

"Rammes mutton" our author leaves "unto those that would be rammish, and old mutton to butchers that want teeth

. . . Pork is most like human meat" and the "inward parts" of swine resemble the inward parts of man. For these reasons "some" have eaten human meat instead of pork. This atrocity our author attributes to "certain Scots." That the English land question was fomenting even in the sixteenth century appears from a long discussion on the evils of giving over large tracts to the raising of deer,—tracts which, if used for cattle, would be able to produce more food for the poor man.

Cogan evidently realized that various parts of animals do not necessarily nourish homologous parts of the human body, for he says: "That heads do not necessarily nourish heads best is seen by people with the falling sickness (a disease of the head), wherefore, I think that reason proceeded first out of a calves head or a sheepes head."

In these war times, the modern reader will sympathize with the author's observations on the eating of fish. We learn that in the sixteenth century England had a Hoover in no less a personage than good Queen Bess herself. The queen had ordained Wednesday for the eating of fish as well as Friday and Saturday, "not for holiness purpose, but as a civil policy. For the many lakes provide much good fish," and if the ordinance were obeyed, one half the days of the year (when fast days are included) would be meatless days. But some are selfish (sighs Cogan) and do not obey.

In this section we are told that "Milk is blood twice concocted. . . . A windie food, but can be made less windie if boyled." It is corrective of melancholy—a property which Metchnikoff would have undoubtedly ascribed to the reduction of intestinal putrefaction following its ingestion. Variety of foods is best (as the obvious way to supply a mixture of amino acids and a sufficiency of vitamines?), according to Hippocrates, for "Everie offence in dyet is wont to be more grievous on a slender diet, than a full dyet, and for the same cause, a very spare, precise and exquisite dyet is not so sure for them which be in ill health, because the breaking thereof is the more grievous." This advice has received ample justification in Germany within the past two years, where scientific studies have shown that medical students existing on the official civilian diet were completely unable to maintain health after taking a moderately long walk. Alive to-day, Cogan would doubtless be of the high-protein school.

The higher level of metabolism of childhood seems to be appreciated since it is advised that "Children, especially lively ones, should not fast, but should eat more." The idea of the

calorie and the fine conception of energy relations as applied to food requirements seems almost realized in practise, while the theoretical explanations set forth to support the advice seem as usual, absurd in the light of our fuller knowledge. Thus, to explain the wise advice that less be eaten in summer, the reader is informed that at this season of the year the perspiration is more copious, giving rise to loss of digestive juices. Carlson is not the first to advance the idea that the feeling of hunger is associated with certain contractions: for, to quote again,

> When to eat is best told by hunger, hunger riseth by contractions of the veynes, proceeding from the mouth of the stomach, for want of meate, for as Leonard Fuchsus teacheth "True hunger ariseth of the feeling of want, when the veines do draw from the stomack as if they did milke it or sucke it."

Perhaps the widest departure from modern conceptions is found in the discussion of "Drinke." But even here the final impression is the same as might very well be obtained from reading a number of up-to-date tracts on the subject; that is, that the whole subject is a matter of controversy. Prohibitionists would surely not agree with Cogan, while, on the other hand, his ideas would be far more to their taste than those of earlier writers quoted.

Water may safely be consumed in England at certain times, provided due precautions are taken. Sanitary engineers will be glad to learn that the relative purity of waters may easily be determined by dipping linen cloths into the samples submitted, the notion being that the cloth drying soonest has been dipped in the purest water. "Some" in certain parts of the country are known to use no other beverage than water. "For young folkes and those of hote complexion, it doeth great harme, and sometimes it profiteth." This is evident pussy-footing. But it is not to be used by the "olde, phlegmatic or melancholie." Wine is the gift of God to man. Does then (Cogan plaintively asks) God love the Germans and French better than he loves the English, since he has given these people a climate so much better suited to the raising of the grape? No, Britons need not fear. This uneven distribution of favorable climate fulfills God's good purpose. He has made England dependent on the Continent for its wine supply so that a spirit of cooperation and of brotherly love will be engendered among the people of these nations.

"Wine is disliked by one in a thousand and these be those of a doggish nature, while it is good for clergymen of ready wit." Students, however, are to be cautioned, as they "have but feeble

brains," so that excess of wine is probably the cause why so few students have profound knowledge and ripeness. Plato forbade the use of wine up to the age of twenty-one, while Galen thought wine should not be indulged in until the age of thirty-five. (Cogan is well above this age.) On the other hand, Arnoldus says "Hipp" thought drunkenness was sometimes expedient in that it provoked vomiting and was for this reason cleansing. "Hippocrates counseled drunkenness once a month forso we might be procured to vomit." Once more Cogan ventures to express an opinion of his own. He believes that one had better be induced to vomit in other ways, less pleasant perhaps, but also "less beastly."

As regards "sleepe," the toxin theory—which in 1919 has yet to be definitely rejected—is supported:

> Here is showed by what meanes sleepe is caused. That is, by vapours and fumes rising from the stomacke to the head, where, through coldnesse of the braine, they being congealed, do stoppe the conduits and wayes of the senses, and so procure sleepe, which things may plainly be perceived hereby: for that immediately after meate we are most prone to sleepe.

We are all doubtless familiar with the common idea that lettuce causes drowsiness. This idea originated before Cogan's time, probably with the ancients, for he says:

> I procured sleepe of set purpose: for it was grievous unto me to wake against my will. . . . Therefore Lettuce eaten in the evening was my only remedie.

It is only a few years since Mrs. Winslow's Soothing Syrup reformed. Under another name, a similar substance, unregenerate, was used by the Italian women before Cogan's time.

> And the women of Salerne give their children the powder of the white Popie seedes with milke, to cause them to sleepe, it may be given otherwise for the same purpose, as in Posset, drinke, or in aleberie, or best of all in a Cawdle [cordial] made of Amondes and hempseede.
>
> Nowe that I have spoken sufficiently of Labour, Meate, Drinke and Sleepe, it remaineth only that I speak of Venus. . . . And as it is last in order of the wordes, so ought it to be the last in use.

These chapters on Venus are interesting. The author's advice regarding the exercise of the sexual functions is not so advanced as that given by the most enlightened medical men, perhaps, but his views are certainly nearer the truth than those of a large part of any modern population. Be it remembered that we still have with us a few well-meaning though poorly informed physicians of the old school who do not hesitate to

advise incontinence for what they would call "meaty" young men. Among three classes of men named by Cogan as able to practise continency, clergymen are said to have this power conferred by the grace of God.

> Yet I do not think the gift of continence so general as it was supposed in times pwast, when all the Clergie were restrained from marriage.

Some stories are then told which indicate that either the gift of God was not always comprehensive enough, or human weakness was sometimes so powerful that all contingencies were not provided for.

Cogan advises thirty-eight as the correct time for men to marry, and eighteen for women. At this time a man has attained self-control, so that the size of his family need not exceed his plans, while the woman is easily ruled. "The first dish that is served up at the marriage feast is miserie and the second is care," proclaims our author. But this is only hearsay. Cogan himself did not marry until three years after the first edition of "The Haven" was published.

"Appended" to the main part of the book is a discussion of the plague, which has been "Twice in Oxford in my time within 12 yeares, being brought from London both times: Once by clothes, and another time by lodging of a stranger." In reality these chapters are as much a part of the book as any of the others. I suspect they are "appended" merely because Cogan can not find any authority for introducing such chapters into a work on hygiene. The cause of the disease is "The influence of sundrie starres, great standing waters never refreshed, carraines lying long above ground, much people in small roome, living uncleanly and sluttishly, that is, and one principall or generall cause, that is, the wrath of GOD for sinne."

Ways of avoiding the plague are given, one of which is to inhale the fumes produced by pouring acetic acid over heated copper. But the most effective measure is precipitant flight. The fatalistic attitude toward the disease is seen in the last chapter of the book:

> Yet thankes be to God hitherto no great plague hath ensued upon it [the plague of 1577]. But if it do (as I doubt it will) unless we speedily repent either the pestilence, or famine, or warre, or all three, I say if it do, then must we do as the Prophet David did, offer a sacrifice unto the Lord, a contrite and humble hart: and say with that holy Prophet Let us fall now into the hands of the Lord, for his mercies are great, and let us not fall into the hand of man. And I beseach God that whensoever it shall please him to visite our offences with his rod, and our sinnes with scourges,

that we may likewise escape the hand of man and fall into the hand of the Lord, to whom be all glorie, prayse, and honour for ever and ever. Amen.

Who was this Thomas Cogan, whose memory has survived three centuries? Born in 1545, he received his B.A. from Oxford in 1563. An M.A. followed in 1566, and a degree of bachelor of medicine in 1574. A year before he received his medical degree, Cogan wrote the "Well of Wisdome . . . containing Chiefe and chosen sayings which may leade all men to perfect and true wisdome as well to Godward as to the worlde . . . gathered out of the five bookes of the olde Testament. . . ." This book was not published for several years.

After obtaining his medical degree, Cogan settled in Manchester, where he was, we are told, not only the leading physician, but high master of Manchester Grammar School, and a "classical scholar." One does not give white elephants to one's alma mater, so we know with what esteem our author regarded Galen and his work. For in a gift to Oriel College in October, 1595, he included five volumes of Galen's "Works," besides Thomas Geminies' "Anatomy" and Malthiolus' "Commentaries on Dioscorides."

At fifty-eight he resigned the position in the grammar school for the purpose, I suppose, of devoting more time to his medical practise. This must have been reasonably large, for he seems to have been very well connected and very well known in the neighborhood. In his spare moments he now prepared a selection of Cicero's letters for school-boys, which was published under the title "Epistolarum familiarum M. T. Circeronis. . . ."

Unless a man's gift to the world be far greater than its Cogans are destined to give, the interest after three hundred years is, I suppose, not so much in his attainments as in the character of the man himself. The reader of biography in 2200 will perhaps remember but few of even Huxley's monographs. The vast amount of work which was the center of his interest will be forgotten. That, however, Huxley successfully engaged in a public altercation with Bishop Wilberforce will long live in the memory of man.

Thomas Cogan died in 1607. Of his will, one sentence reveals the man. Given the single bone, the character of the man may be reconstructed. For, after bequeathing "certain moneys to the poor in Manchester" and to his "poore neighboures . . . all my Shirts, one appece," he says, "I give to every Scholler of the ffree Schoole in Manchester, 4 d. apeece. . . ."

John Bunyan or Milton would have moralized over the gift. Dickens would have become intensely sentimental. Tears would

have freely flown. Samuel Johnson would have excluded Scotch scholars from the benefits to be conferred and would have stipulated that the money be spent on something which no boy of tender years should possess. But not Thomas Cogan. He knew boys. And schoolmasters seldom do. In knowing boys, he knew and understood men. And after all, it is because of this knowledge and because of the injection of his personality into the book he wrote that makes it still interesting.

THE DISADVANTAGES OF BEING HUMAN

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MAN early came so habitually to regard himself as the crown of animate nature, "the masterwork, the end of all yet done" in Milton's words, that he long ago arrogated to himself the perfection of the gods and to-day ordinarily blinds himself to the natural imperfections of his body and the disadvantages of being human until his machinery is in such poor working condition that he has to go to the doctor's. Far back in the days of pre-history, some genius suggested that man was made in the image of god and from that time on, there has been a pride of birth on the part of man, reaching a climax with the Junkers of Prussia and their super-manhood.

From time to time, however, prophets and seers have abundantly appreciated the imperfections of humanity, as when the Psalmist exclaims in an outburst of pessimism: "I am a worm." The ministers of the Scotch church in the seventeenth century, says Metchnikoff, quoting Buckle, the historian of civilization, thought there was nothing more surprising than that the earth could contain itself in the presence of that horrid spectacle, man, and that it did not gape as in former times, to swallow him in the midst of his wickedness. Even in our own time, Mark Twain more than once bemoaned the fact that he was a man and that humanity had very little to be proud of. The consideration of the physical disadvantages of being human is no new theme, but in the flush of victory over the arrogant Huns under the leadership of would-be super-men, it may be especially salutary to attend to this subject for a short time in order that the pride of creation may the better appreciate how far short of the gods he falls. In spite of thankfulness for being fearfully and wonderfully made, there are, as I shall show, some respects in which we may indeed be in fear of our precarious machinery and stand in amazement at the maladjustments of our own bodies.

At the same time that I wish to point out especially the disadvantages of being human from the bodily standpoint, I would not leave the impression that man is nothing but a bundle of mistakes and a poorly built machine. In spite of obvious de-

fects he is, like every living creature, closely adapted to his environment and must, within limits, constantly adjust himself to changes in the environment. The crawling *Amœba* no less than the Marathon runner and the calculating philosopher are from moment to moment adjusting their internal relations to external relations with wonderful nicety. The muscles of the Marathon runner are absorbing oxygen as well as fuels necessary for their explosive action in contracting. The brain of Newton in contemplation of the law of inverse squares is absorbing molecules from the blood and discharging different molecules which have been produced by the activity of the brain cells. The failure of the heat-regulating mechanism to keep the bodily temperature within a few degrees of 98.6° Fahrenheit, or to respond to the increased temperature of the bake shop or boiler room causes illness and possibly death. From certain points of view the human mechanism is marvellously adapted and warrants man's high regard for himself. But in no case is adaptation to environment absolutely perfect. The more closely an organism is investigated, the more apparent is it that there are present disharmonies and imperfections. Johannes Müller sixty-odd years ago showed that in spite of the perfection of the eye as an optical instrument, it is very imperfect in correcting aberration of light. An ordinary camera or microscope made with so little regard for optical axes and irregularities of curvature of lenses would be a most unsatisfactory instrument. Helmholtz, to whom we are indebted for so large a part of our knowledge of the optics of the eye, says: "Nature seems to have packed this organ with mistakes, as if for the avowed purpose of destroying any foundation for the theory that organs are adapted to their environment." And yet the eye does very well for most of us and we are thoroughly happy in the possession of this structure whose lenses are not exactly curved and centered!

Disharmonies abound in practically all forms of living things. Rudimentary structures, which have outlived their usefulness, occur in all higher animals and are constantly "getting in wrong" with things about them. But besides the rudimentary structures there are others which may be regarded as incipient structures which have not yet attained the size and complexity necessary for their perfect functioning. Besides imperfect structures, a great many animals exhibit instincts or reactions to stimuli which seem to go counter to the best interests of the individual and the race. Perverted tastes in man are no less destructive than some perverted reactions in ani-

mals. For instance, the moth flying into the candle flame represents a maladjustment of the moth's mechanism and its environment which results in the destruction of untold myriads of moths. The nervous mechanism of the moth in this case is as much out of correspondence with its environment as the broken shaft of an ocean liner which in its rotation beats a hole in the side of the hull.

It is hard to explain in most cases the origin of these disharmonies, although in general it may be said that they represent a failure on the part of all the organs of the body to keep pace with the changing environment, or of the several organs to keep pace with each other. Some organs seem to be less plastic than others; some, on the other hand, apparently get into the habit, so to speak, of changing too rapidly. To enter into a discussion of the causes of these maladjustments that are disadvantageous to the organism would take us too far afield into the fundamental problem of biology, the origin of variations. It is enough at present to remember that the survival of the fittest is in spite of these defects.

Many of the defects of the human body may be referred back from the mechanical point of view to the present habit of striding about on two legs, a habit of very recent phylogenetic development—a fact vouchsafed by the length of time the infant crawls on "all fours" and the slowness with which it assumes the bipedal method of locomotion and exhibits a fairly well adapted structure for the upright position. So late in phylogeny has this position been acquired that many parts of the body have not yet become perfectly fitted for this remarkable experiment. So closely adjusted to each other, however, are the different parts of the body that any change in one part almost always brings about a change in every other part. As we shall have occasion to show, the upright posture has affected directly the skeleton, the muscles, the blood vessels, the jaws and teeth, and probably indirectly other parts of the alimentary canal and the organs of respiration; while many students of human evolution regard the abnormal development of the intellect of man as a direct outcome of the upright position with the freeing of the hands to learn of the environment by handling and the elevation of the principal sense organs in order to give man a broader horizon.

Let us turn first to a consideration of some of the defects of the skeleton which are associated with the upright position. The ancestral foot of man was characterized by the slant of the sole in relation to the axis of the leg so that the sole could

be applied more perfectly to the cylindrical trunk of the tree, to which primordial man was fairly well adapted. In order to bring about this position of the foot, the heel bone is skewed and set off slightly to one side in such a way that when the anthropoid ape of to-day attempts to walk on the ground, it is necessary for the sole of the foot to be turned toward the middle plane of the body with the heel bone brought beneath the axis of the leg and the weight of the body borne on the outer edge of the foot. Man's heel has moved over somewhat further toward the inner side of the foot in order to bring the sole squarely on the ground, but the parts have not become perfectly adapted to the new arrangement for there is still a little weakness that manifests itself as fallen arch in thousands of human beings. The weakness of the arch in great measure is due to the long stretch between the ball of the foot and the heel and an imperfect support of the arch on the inner margin of the foot, a defect which is remedied often by the surgeon in treating fallen arches by extending the heel of the shoe forward along the inner side of the instep and also by building up the inner side of the heel to throw the sole of the foot inward and shift the weight of the body more to the outer side of the foot.

Another defect of the skeleton occasioned by the upright position is in the pelvis, which is attached to the vertebral column and encircles the posterior end of the alimentary canal and genital ducts and affords attachment of the hind legs. In the quadrupeds this part of the skeleton serves almost entirely for the attachment of the hind legs and plays only a very secondary rôle in supporting the viscera which are suspended along the entire length of the body cavity by mesenteries. As soon as the trunk assumes an upright position, however, the weight of the viscera pulls toward the tail instead of toward the underside of the animal and the mesenteries afford a far less efficient support. To compensate for this, however, the pelvis changes its function somewhat, and consequently its form, and instead of serving simply as an attachment for the limbs to the vertebral column, it now becomes a basin to aid the mesenteries in supporting the viscera by a partial closing together posteriorly so that a comparatively small opening is allowed for the passage of the alimentary canal and the genital ducts, and a flaring outward at the anterior end. This is not inconvenient or harmful in the least in the male, but in the female it increases the difficulty of parturition seriously, especially among the white races which have somewhat larger heads and less compressible skulls at the time of birth. Com-

plete support of viscera and sufficient passage for the fetus at birth are mutually opposed to each other with a consequent disharmony.

The upright position has brought about several disadvantageous maladjustments in the blood vessels. Unlike the quadrupeds, in which the axis of the body is carried habitually more nearly parallel with the ground, in man the axis is vertical so that the blood vessels especially of the lower part of the leg must support an unusually tall column of blood and thus be subjected to a relatively great pressure. This pressure is borne by the arteries as well as by the veins, but the strong muscular walls of the arteries are easily able to withstand the strain of the weight of blood lying above them and the thinner walls of the deep-seated veins supported by the surrounding muscles are not likely to give way. But in addition to the deep-seated veins there are several superficial veins which lie beneath the skin only and so are deprived of the added support of the surrounding muscles. The walls of these vessels frequently give way, particularly in those who stand for long periods and whose blood vessels may be slightly weak. When these vessels rupture under the pressure of the blood, varicose veins result which have discommoded thousands upon thousands of human beings. The offending blood vessels may be supported by bandages, or in extreme cases they are generally removed by the surgeon and the blood which ordinarily passed through them finds its way through other vessels which gradually enlarge to accommodate the increased blood flow thrown upon them with no apparent inconvenience.

The veins of man exhibit further lack of adaptation to the upright position by the arrangement of the valves. These valves, which are pockets to prevent the blood from flowing away from the heart, are obviously important only in those veins which have a vertical course and in which the blood flows upward to reach the heart. Thus, the valves are found for the most part in the veins of the fore and hind limbs and in the intercostal veins. Were the valves thoroughly adapted to the upright position they would be quite differently distributed. There would be none in the veins between the ribs which have a nearly horizontal position in man and there would be an abundance of them in the large vessels entering the heart from the abdominal region. The great vein which receives blood from the legs and kidneys and the great vein which brings blood from the stomach and intestines are both without valves so that the circulation in the lower extremities and the abdom-

inal organs is retarded and the pressure on the veins of the legs is sometimes seriously increased. Furthermore, congestion of the abdominal organs, especially the liver in which the circulation of the blood is at best sluggish, is frequent in the human race, a condition which would be improved if there were valves in the veins leading from the different organs which would relieve the tendency to back pressure and consequent retardation of the circulation.

The absence of valves in the great abdominal veins works hardship in another way. In case the extensive vessels of the alimentary canal suddenly enlarge as they do under the stimulus of a blow on the solar plexus, the blood is drained rapidly from the brain and the recipient of the body blow falls in a faint. With valves in the veins of the trunk to prevent the back flow of blood, the vessels of the brain would not be drained so rapidly and the insensibility would not follow such temporary derangements of the abdominal circulation.

The straightening up of the body involves the extension of the trunk on the thigh which exposes certain vessels dangerously. This condition is met with in no other vertebrate, and consequently is one of the most highly specialized conditions in the human body. Whereas in a dog or other quadruped, the groin is deeply seated between the thigh and the abdominal wall, in man it is fully exposed and unprotected. Just below the groin on the front of the thigh, a little toward the median side, is the superficial femoral artery, which is one of the principal channels by which blood is carried to the leg. In an animal with the thigh habitually bent on the trunk, this superficial vessel lies deep in the crease between thigh and trunk, securely protected from tooth and talon of the aggressor. But not so in man. With the feet spread in order to give him a broader base and a more secure balance, the femoral artery lies exposed in a most dangerous way, ready to be torn open by talon or spear. The genital organs are also dangerously exposed in upright man while in the quadrupeds they are fairly secure against frontal attack.

Not the least of the disadvantages of the upright position is the exposure of the entire abdominal wall to injury. As if it were not enough to expose to teeth and talons a large area which is unprotected by skeleton, the whole trunk is flattened and broadened so that a larger target for the attacker is afforded and some vulnerable points are dangerously exposed. It is hardly necessary to call attention to the solar plexus which is but poorly protected behind only a moderate rampart of vis-

cera and which must in the history of the human race have caused the downfall of many a fighter before the modern pugilist came to realize the importance of this weak point of human anatomy. In this connection, too, it is interesting to note that some of the most skilful pugilists assume a crouching position in the prize ring which incidentally protects the defenseless abdomen more perfectly and presents a more formidable rampart to the enemy.

Turning aside from some of the defects which are the immediate outcome of the upright position we may turn for a moment to some defects which are not so closely connected with standing "upright, with the front serene."

The skin of man has lost certain structures which render it a less perfect hull for the internal organs than is the skin of many of the lower mammals. The coat of hair, so scanty over most of the surface, no longer affords a protection against cold or teeth and talons like the shaggy mane of the lion or the heavy pelt of the bears. In fact, the imperfect hair follicles of man are a positive disadvantage, for bacteria lodge in these tiny cups and often set up inflammation, giving rise to various eruptions of the skin. In the history of the race, thousands of men must have suffered untold annoyance from this cause and in many cases serious blood poisoning must have followed through the injury of these eruptions. The scanty coat of hair may have proven an advantage by affording poorer lodgings for fleas and other bodily vermin, but this advantage could hardly compensate for the exposure to cold and mechanical injury which a loss of hair involves.

Together with the loss of hair has also gone an extensive loss of dermal musculature by means of which the skin can be twitched, as is well seen in the horse when troubled with flies. This extensive layer of muscle has disappeared from the human species except on the front of the neck and the face and the scalp. Unlike the quadrupeds that can scare off insects without moving the limbs, man is under the painful necessity when disturbed by crawling insects of using a limb to chase off the offender like the proverbial Jerseyite in the mosquito season. It is conceivable that many of our forbears must have lost their balance in the tree tops in trying to drive off an insect with hand or foot. The advantage that would arise from being able to wriggle the skin independently of the limbs and thus overcome the irritation of tickling insects is obvious.

The skin muscles in man, as already said, are limited to the front of the neck and the head. By means of them mankind is

as well as some of the apes, able to express various emotions. We draw down the corners of the mouth to express sadness and wrinkle the forehead in perplexity, and draw the corners of the mouth upward to indicate hilarity of spirit; but these functions are decidedly secondary in importance to the scaring off of insects.

There are rudimentary muscles attached to the external ear which are entirely comparable to those by which the ear of the grazing animals particularly is directed toward the source of the sound and by virtue of which the acuteness of the hearing is increased considerably, a fact borne out by the practise of those whose hearing is defective of holding the hand to the ear and making a kind of funnel with the large end toward the source of the sound. The loss of mobility of the ears has probably not been compensated.

The defects of the eyes as optical instruments have already been alluded to. But the defects here are as nothing in comparison with those of the neighboring organ of smell. So imperfect is the sense of smell in man that it is only by courtesy that we may be said to have such a sense. We recognize pleasant and disagreeable odors, if they are sufficiently concentrated, together with flavors, which we refer quite generally to the sense of taste; but the delicate odors that are appreciated by many of the lower animals are totally beyond our powers. To the dog with its sense of smell a whole world of sense impressions of which we know absolutely nothing is open. The human subject is generally unable to appreciate the difference in odor of the secretions of the skin under different strong emotions although there is abundant evidence that the nature of these secretions is modified by emotions. On one occasion I was greatly terrified at the sight of my small child calmly sitting on the edge of a roof upon which she had climbed, and, although I had just returned from my bath, I was conscious of a most fetid odor from my skin immediately after I had rescued the child—the odor of fear. With a sense of smell acute enough to perceive the passing variations in our bodily secretions would our knowledge of mankind who come in contact with us not be vastly increased? Sherlock Holmes equipped with a sense of smell keen enough to differentiate between the odor of sanctity and deceit would have made the feats of Conan Doyle's hero pale into insignificance! Primitive man might have escaped many an enemy by perceiving the odor of the skulking stranger suffering from the necessity of concealing his identity, and fearing discovery.

Nor is it alone in the function of the organ of smell that man is defective. The structure of that organ is rudimentary as might be expected and like all such structures is liable to great variation in form and to various diseased conditions. The sensitive organ of smell is spread out over a most complexly folded scroll of bone in the nose so that there is little chance for any fraction of the air drawn over it to fail to come in contact with the sensitive membrane. But these turbinal bones in the human subject are greatly reduced in size in comparison with our more sharp scented animal cousins and are often so deformed as to make little pockets in which the secretions of the nose accumulate and undergo decomposition. The disinfecting of the nose and the removing of these troublesome pockets in which mucus accumulates is an important work of the nose specialist. And this is largely due to the rudimentary condition of this sense organ whose function we of polite society are all too prone to taboo.

Before leaving the organs which cooperate in the function of respiration, it is of interest to note a trivial defect in the lungs which may have been the cause of countless deaths in the past and which seems to indicate a failure on the part of the body to be perfectly fitted for its environment. As is well known, the trachea passes from the mouth, or more properly the pharynx, to the lungs, dividing into the two bronchial tubes. The right bronchus is given off from the trachea at more nearly a right angle than is the left so that mucus rolling downwards, or disease germs carried down by the air current, find their way into the left lung with greater frequency than into the right lung. Correlated with this difference in the form of the two bronchi is the occurrence of pneumonia infections. In the typical case of lobular pneumonia, the congested areas cluster around the extremity of the left bronchus more closely than the right in exactly the fashion that would be expected when it is remembered that the germs of pneumonia do not have the power of independent locomotion but are wafted whither the wind listeth and multiply wherever they find a favorable environment.

The respiratory organs have suffered directly as a result of the upright position of man, for the emancipation of the forelimb from supporting the weight of the front part of the body has brought about a great change in the movements of respiration which have not been accompanied by perfectly adapted changes in the lungs. The anthropoid apes in captivity and man are very prone to tuberculosis of the lungs which

gains a foothold generally in the more poorly ventilated parts of the lungs, the apices. In the respiratory movements of the anthropoid apes and man the diaphragm plays a very important part in enlarging the capacity of the thoracic cavity. By its contraction, the convex, domelike diaphragm is flattened and the length of the chest is thereby increased. But in addition to the diaphragm are the intercostal muscles and certain auxiliary muscles of respiration which extend from the shoulder blade to the ribs and from the arm to the ribs, the serratus and pectoral muscles principally. With the arms free, these last named muscles, which are very strong, in contracting draw the shoulder blade ventrally to increase the reach, as for example in striking a blow with the fist. With the arms free, the ribs serve as the fixed point of attachment and the shoulder blade is the movable portion of the mechanism. In the quadrupeds the relative importance of the movements of the diaphragm and the external muscles of respiration is almost reversed. In the quadrupeds bearing a part of their weight on the forelimbs, the arm becomes fixed and a contraction of the serratus muscle results in a raising of the ribs and consequent enlarging of the cross section of the chest. The gymnast swinging from horizontal bar or trapeze fixates his arms so that these muscles in contracting pull up the ribs and ventilate the apices of the lungs particularly well. On the same principle, in some diseased conditions in which shortness of breath is experienced, the patient finds it necessary to rest his hands on the back of a chair or other support in order to get his breath. But in so doing he is virtually becoming quadrupedal, at least to the extent that his arms become fixed and the strong external muscles of respiration aid in the elevation of the ribs in a way which is impossible where the arms swing freely.

The liberation of the forelimb from the work of supporting the body weight has been responsible further for several changes in the front part of the digestive system which are not unmixed joys although our ideas of human beauty are curiously enough closely bound up with them. The hands have become prehensile organs and the earlier prehensile function of the jaws has been lost and the jaws have shortened. By becoming a hand feeder, man's teeth have grown smaller and more closely crowded together. The teeth no longer have the important function which they once had, for the incisors are aided by the bare hands or knives and the grinders are rendered less important by pestle and grinding mill. The wisdom teeth show several unmistakable signs of degenerating. They are smaller

than the molar teeth immediately in front of them, they are frequently imperfectly cut, and the cusps and cavities of the grinding surfaces fit with their opponents less perfectly than in the teeth in front. In fact the wisdom teeth fail to be cut in about ten per cent. of adult human beings. With the imperfect functioning of the wisdom teeth is a great tendency to decay, and on account of the delicacy of the membrane about their roots which is not stimulated as that around more frequently used teeth, infections and abcesses are much more common.

Even the milk teeth of children are weakened and become liable to decay in a way which indicates that they are far from well adapted to their purpose. How far the feeding of gruels and other foods offering little resistance to the teeth in chewing plays a part in inducing or facilitating decay, it is hard to say, but examination of the skulls of children of primitive peoples as late as the beginning of the Christian era shows that it is only very recently that the milk teeth have fallen so far short of expectations.

Even more rapidly than the disappearance of the teeth has been the shortening of the jaws which has brought about a condition giving much work to modern dentists. The shortening of the jaws has crowded the teeth together so firmly that particles of food decompose in the crevices with the formation of acids which soften the enamel. The handsome human chin, prominent and forming a decided angle, which is a measure, so called, of our determination, is the result of the more rapid shortening of the margin of the jaw bearing the teeth. The prognathous jaw of the Australian Bushman may not be a thing of beauty according to our standards of human beauty, but from the point of view of mouth hygiene, it is a consummation devoutly to be wished.

Other parts of the alimentary canal have lost their original function and to that extent have become liable to disease with all its consequences. Preeminent among useless parts of the alimentary canal is the vermiform appendix that has won an immortal fame through mortality due to inflammation of the little member. The anthropoid apes all have an appendix which is invariably longer than that of man. Its function in the human species, so far as our knowledge goes at present, is negative. In fact there are features of its embryonic development that would seem to indicate that it is simply one step in the reduction of the cæcum to which it is attached and which in like fashion is also undergoing further decrease in the human subject. The cæcum in herbivorous forms attains a large size and

probably plays an important part in the digestion of the coarser parts of vegetable foods like cellulose. But in the human species, and as far as that is concerned, in the apes as well which have already begun to feed on more delicate foods including fruits and insects, this part of the alimentary canal has undergone considerable reduction. In the human subject the cavity of the cæcum is cut off completely from that of the rest of the alimentary canal in about twenty-five per cent. of the subjects examined.

On account of the relations of the appendix to the cæcum and intestine and its rudimentary character, the contents frequently stagnate and undergo decomposition so that infections are frequent which produce appendicitis.

Another portion of the alimentary canal which has lost its function to a greater or less extent is the large intestine or colon. Like the cæcum, the colon probably was originally important in completing the digestion of cellulose, which forms so large a part of the tissue of plants and which resists the action of the digestive juices. But in the human subject who, partly on account of the weakening of the teeth, does not eat cellulose in such large quantities, the colon has ceased to be an important organ of either digestion or absorption. It serves in the human largely as a reservoir for the indigestible portions of the food from which water is absorbed. The undigested food residues in the large intestine, particularly the rectum, decompose under the influence of countless bacteria which early in life find their way thither. The products of decomposition if allowed to remain in the colon are absorbed and produce the discomfort and inefficiency of constipation. Without a large intestine, no serious inconvenience follows, as shown by the cases of removal of that organ. There is one case recorded in medical literature of a French woman who lived a perfectly healthy and normal life for thirty years after the removal of the whole large intestine.

It is not only in the structure of different parts of the body that disharmonies may be found. Various functions of the body or reactions to stimuli may become perverted and work terrific damage on the individual and his progeny. It would be of great interest to analyze these disharmonies but the chapter is a long one and only one may be mentioned which has a physiological basis and which has deep significance in relation to the bacterial parasites. As is well known about one half of all the deaths are due to parasitic bacteria which gain entrance into the body and multiply and give rise to the poisons which in so many cases are fatal.

It would, however, be very misleading to leave the impression that there is no defense of the body against parasites like the pathogenic bacteria. In the course of evolution man has become protected against a large number of germs and has developed a number of defenses which stand him in good stead and without which it would be highly improbable that he could survive for long. For example, the layer of impervious, resistent, horny skin covering the whole body serves as a bulwark against the hordes of ever-present bacteria whose activities and readiness to attack are only too manifest when for any reason the integrity of the skin is broken as in a wound or surgical operation, when extreme precautions must be taken to prevent the entrance of living germs. Then, too, the respiratory tract including certain parts of the nose and the windpipe and bronchial tubes are lined with ciliated epithelium by which all particles which become embedded in the mucus secreted by intervening cells are swept outwards. Were it not for the protection thus afforded by the normal secretion of mucus and the constant sweeping of the cilia, infections of the lungs and respiratory tract would cause a far larger proportion of deaths than at present. The acid of the gastric juice also kills many bacteria which are taken into the stomach with the food and which would multiply rapidly in this otherwise ideal place for their multiplication. But the most important defenses against microbes are the so-called antibodies which are manufactured in the body and which either neutralize the poisons produced by parasitic bacteria or dissolve the germs after they gain entrance to the fluids of the body.

The human mechanism has scarcely begun to develop the antibodies which it is capable of producing, as is evidenced by the fact that man is susceptible to many diseases naturally but becomes immune under the stimulus of vaccines and viruses artificially administered, or the stimulus of an attack of the particular disease. The potentialities of the body in this direction are far beyond the actual accomplishments. What has been actually acomplished by means of the administration of antitoxin of diphtheria is indicated, for example, by the fact that mortality from this cause has been reduced from 50–60 per cent., to 12–14 per cent., by its use. Smallpox, plague, cholera, typhoid fever and a host of other diseases that have destroyed their legions, we know now can be prevented by the activity of the antibodies produced by the living human being under the stimulus of vaccines and sera. Thus a perfect immunity may be acquired under the stimulus of inoculation with

anti-typhoid serum, as has been amply demonstrated in the army within the past few years. It is a matter of scientific knowledge that during the Spanish War, in 1898, every fifth man in our army of 107,000 was attacked with typhoid; but as a result of general vaccination against typhoid in the army at present, in 1916 on the Mexican border, out of 20,000 men only one man fell ill with typhoid in spite of the fact that it was prevalent in nearby towns.

This brief survey of the more obvious defects of human structure and function that put man at a striking disadvantage in contrast with some of his distant cousins who inhabit this earth ought perhaps to help us orient ourselves more perfectly in the universe. As a mechanism, man is far from perfect, but with his more perfect brain with its powers of logical reasoning and invention, he shows a capacity to adjust himself by the use of tools and other devices of his ingenuity to a rapidly changing environment, to defend himself against untoward circumstances and more than hold his own in competition with the other species of organisms on the earth to-day.

THE MECHANISM OF EVOLUTION

IN THE LIGHT OF HEREDITY AND DEVELOPMENT[1]

II

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3. *The Germplasm Theory*

The germplasm theory of Weismann substitutes a simple and rational conception for this complicated and inverted view of development, heredity and evolution. According to Weismann the intrinsic causes of development are in the germplasm and not in the soma of the developed organism; the germplasm is continuous from generation to generation and is not made anew in each generation by the soma; the germplasm is relatively stable as compared with the somatoplasm, so that while the latter undergoes many changes in response to environmental stimuli, the former undergoes few. Heredity is the transmission of parental germplasms to offspring, usually through the male and female sex cells; ontogeny is the conversion of portions of the protoplasm into the differentiated tissues of the developed organism, while other portions remain unchanged, especially in the sex cells; evolution consists primarily in the transmutation of one type of germplasm into another, not of one type of developed organism into another. Thus at one stroke the germplasm theory, if accepted, eliminates most of the older theories of evolution and substitutes in the place of mysterious and even mystical causes relatively simple and mechanical ones.

Shortly after the publication in 1892 of Weismann's book on the "Germplasm" there was a general outcry against the highly speculative character of this theory. It was said that whereas genuine progress in science depends upon the control of the scientific imagination by the brake of observation and experiment, Weismann had allowed his imagination to run wild without any brake at all. One critic (Ryder) said that there

[1] William Ellery Hale Lectures before the National Academy of Sciences, Washington, April 16 and 18, 1917.

was no more evidence for the existence of a germplasm separate and distinct from the body plasm than for the existence of "bowlegged hobgoblins on the back side of the moon," while another critic (Romanes) asserted that Weismann's analysis of the germplasm into units of seven different orders, such as *biophores, determinants, ids,* etc., had no more basis in reality than Dante's seven circles of the Inferno.

Nevertheless, in spite of the general outcry against it the germplasm theory is to-day more widely accepted than ever before and all recent work on heredity and evolution confirms the essential features of Weismann's theory. Relatively minor details of the original theory have been modified or abandoned as the result of further work, but its main foundations stand fast. Among the important confirmations of the germplasm theory

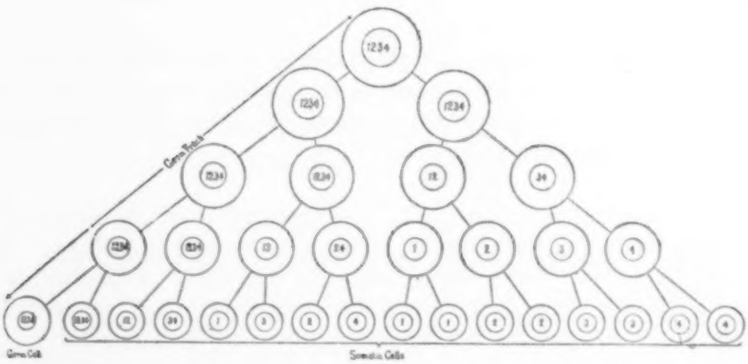

FIG. 9. *Diagram of the Mechanism of Ontogeny according to Weismann.* The determinants in the nucleus (1, 2, 3, 4) are supposed to be distributed differentially to the various somatic cells, whereas they are all found in the germ cells.

may be mentioned the great mass of work on Mendelian inheritance and germinal factors, while an important corollary of this theory is Johannsen's suggestive distinction of *Phenotype* and *Genotype*, the former being the developed type or soma, the latter the hereditary type or germplasm.

In one respect at least Weismann's theory was probably wrong and this was in the supposed manner in which the hereditary germplasm presides over development. Differentiation, according to Weismann, is caused by the disintegration of the germplasm, portions of it going into one cell and other portions into other cells, which cells differentiate into various kinds of tissue cells, depending upon the portions of the germplasm which they receive (Fig. 9). But there is no satisfactory evidence of

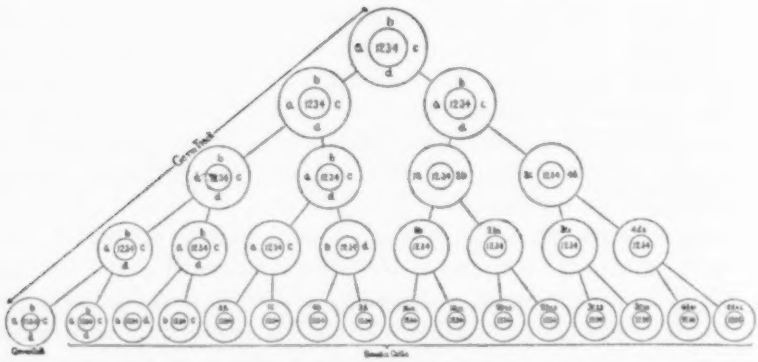

FIG. 10. *Diagram of the Mechanism of Ontogeny according to recent Workers.* The determinants or genes (1, 2, 3, 4) are distributed equally to every cell, but the cytoplasm is distributed differentially (segregation). The same determinants acting upon different cytoplasms produce different results in various somatic cells (new formation).

the qualitative division of the germplasm while the causes of differentiation may be explained in another way, as we shall see when we come to consider the mechanism of development, and as is indicated in Fig. 10.

Germplasm Identical with Chromatin, Somatoplasm with Cytoplasm.—The germplasm is not a mere logical abstraction; its distinctness from somatoplasm, its relatively great stability, its continuity from cell to cell, from generation to generation, from species to species are not unsupported hypotheses. We have within every cell two substances which possess these different qualities of germplasm and somatoplasm, as Hertwig, deVries, Roux, Weismann and many others have pointed out. There is convincing if not conclusive evidence that the germplasm is located mainly or entirely within the chromatin of the nucleus, while the somatoplasm, or that portion of the protoplasm which undergoes differentiation into the various structures, tissues, and organs of the developed body is the cytoplasm or substance of the cell body. Osborn (1915) accordingly calls the former of these the "heredity-chromatin," but it seems to me preferable to preserve the time-honored and familiar designations which have hitherto been used; accordingly in these lectures germplasm is thought of as located in or as identical with the chromosomes of the nucleus, while somatoplasm is located largely in the cytoplasm.

Not only is it possible to give the germplasm a cellular "habitation and a name," but it is possible to trace it from cell

to cell, and from generation to generation and thus to establish its continuity; it is possible to show that the chromatin is more stable than the cytoplasm, that it comes in approximately equal quantities from both parents and that it is distributed equally to every cell of the developing organism; it is known that the quantity of this germplasm which goes into every mature egg or sperm cell is reduced to one half that found in the other cells of the body and that when egg and sperm unite in fertilization the normal quantity is again restored, and it is known that by means of this reduction and by the subsequent union of the sex cells in fertilization new combinations of germplasms are produced.

Through the work of Morgan and his pupils we are now beginning to understand something about what Weismann called "the architecture of the germplasm" and indications are at hand of the way in which this germplasm controls the differentiations of the egg and hence the development of inherited characters; and while we know little or nothing as to the precise manner in which the germplasm undergoes evolutionary changes no one acquainted with the evidence doubts that evolution can take place only through changes in the germplasm.

4. *The Causes of Development*

It is interesting and somewhat depressing to observe within what narrow limits the minds of men move in dealing with any great problem like that of the causes of development, whether of ontogeny or phylogeny. The modern investigator arrives at some conclusion which seems to him new and "epoch-making" only to find as he traces his discovery to its sources that it is merely a variant on some old, well-recognized theme, or in the language of modern biology a mere "fluctuation," and not a "mutation." There is nothing wholly new under the sun even in our theories, and yet there is development of ideas and evolution of theories. The outlines of the truth have long been known, but recent work has supplied many details.

Within the realm of scientific, that is of mechanistic, causation two general methods of explaining organic development, whether of a species or of an individual, have been proposed. The one finds the causes of such development in the environment, the other within the organism itself.

(*a*) *Environmental Causes of Development.*—Formerly great emphasis was placed upon the influence of environment in both ontogeny and phylogeny. The theory of epigenesis held that

the distinctive causes of development were to be found in external forces and conditions rather than in the germ cells, which were supposed to be very simple in organization and practically without differentiation: and while no one now maintains, as St. Hilaire once did, that environmental conditions may determine whether an egg will develop into a reptile or a bird, it is still popularly supposed that stature is caused by the quantity and quality of food, sex by food or temperature, mentality by education, and that in general individual peculiarities are due to environmental differences.

From the earliest times it has been believed that one species might be transmuted into another by environmental changes and that even life itself might arise from lifeless matter through the influence of extrinsic conditions. The organism was regarded as being passively moulded by outside forces. Thus the theories of evolution of Buffon, Lamarck, St. Hiliare and to a certain extent of Darwin also were based upon the direct or indirect influence of environment in causing evolution. The sharp contrast which exists in certain respects between the two systems known as Lamarckism and Darwinism does not concern the influence or non-influence of environment in causing changes in organisms. Lamarck held that individual *adaptations* occur in response to environment and that these adaptations are inherited and thus become the building materials of evolution, but he did not attempt a mechanistic explanation of individual adaptations themselves. Darwin held that *variations* arise chiefly through changes in environment—"Variations of every sort," he said, "are caused by changed conditions of life"—unfavorable variations are eliminated by the environment while adaptive ones persist. Thus Darwinism offers a mechanistic explanation of adaptations, but it does not explain how changes in environment cause variations. The distinction between Lamarckism and Darwinism is to be found, therefore, in the manner in which adaptations are supposed to arise rather than in the causes of variation, for in both systems variations are usually attributed to environmental causes.

(*b*) *Intrinsic Causes of Development.*—Recent work on ontogeny and phylogeny places greater weight upon intrinsic than upon extrinsic factors in development. Modern studies of development have demonstrated the overwhelming importance of heredity as compared with environment; indeed it is doubtful whether environment serves in any other way than to hasten or retard, to stimulate or inhibit certain developmental responses

of the organism, while the character and kind of response, the possibilities and limitations of development are determined by the organism itself.

In similar manner it is held by many geneticists that the distinctive or differential causes of evolution lie within the organism, and that environment plays a wholly subsidiary part. The real problem here is as to the causes of heritable variations, for it is universally recognized that these and these alone constitute the building materials of evolution. Certainly most of the variations which are caused by environment are not inherited and at present no unequivocal cases are known in which somatic variations caused by environmental change are known to be inherited.

Non-heritable variations are usually if not invariably caused by environmental changes, but many students of heredity maintain that heritable variations are always due to intrinsic or constitutional causes. Just as the constitution of the fertilized egg determines the nature of the organism which develops from it, so the constitution of the germplasm determines the nature of the heritable variations which arise from it. Davenport says, "As the egg develops into the complex adult with multitudes of differentiated cells, so primitive germplasm has developed into all present and past organisms." But this does not signify that everything which appears in the course of ontogeny or phylogeny was actually or "factorially" present in the egg or in the primitive germplasm. Development is not merely a "sorting-out process" but also a creative one. Everything which comes out of an egg or out of primitive germplasm was *potentially* in it or it could never have come out of it, but such an "explanation" of ontogeny or of phylogeny does not really explain anything. In similar manner it might be affirmed that the entire world, living and non-living, was *potential* in the material from which the world was made, without leaving us any the wiser.

Overemphasis upon the intrinsic causes of evolution and neglect of the extrinsic causes has led to the extreme view that elementary species, pure lines, unit characters or inheritance factors are immutable, except that in some instances they may undergo digressive changes like those of the radium atom, which changes are wholly independent of environment. According to this view "The foundation of the organic world was laid when a tremendously complex molecule capable of splitting up into a vast number of simpler vital molecules was evolved"

(Davenport, 1916), and evolution consists merely in "the unpacking of an original complex" (Bateson, 1914) so that it is a process of devolution, or simplification. According to this bizarre view, man would be, as Castle has said, "a simplified ameba." Such an extreme position is not unlike the "palingenesis" of Bonnet and might properly be called "natural creation" rather than "evolution," for as Caullery says, "there is no considerable difference between such views and creationist ideas."

(*c*) *Epigenesis and Endogensis.*—In the field of ontogeny no one now maintains the extreme view either of epigenesis or of preformation. The germ cells are not unorganized and wholly undifferentiated as Wolff maintained, nor do they contain a preformed organism as Bonnet taught. Development is not the creation of organization by outside forces nor is it the unfolding of an infolded organism.

> "We should look upon the germ as a living thing, and upon development as one of its functions. Just as the character of any function is determined by the organism, though it may be modified by environment, so the character of development is determined by heredity, that is by the organization of the germ cells, though the course and results of development may be modified by environmental conditions" (Conklin, 1915).

In similar manner most students of phylogeny maintain that evolution is the result of both extrinsic and intrinsic causes, of environmental and organismal factors. In the words of Darwin,

> "Although every variation is either directly or indirectly caused by some change in the surrounding conditions, we must never forget that the nature of the organization acted upon essentially governs the results."

(1) *Environment and Heredity.*—Differentiation and variation are conditioned by the organism and by the environment, by intrinsic and by extrinsic causes. In general the direction and character of individual development are determined by the organism, that is by heredity, while environment exercises a stimulating, inhibiting or modifying influence on the organism. It is altogether probable that the general factors of evolution are precisely the same as those of individual development, namely heredity and environment, and that their method of acting is the same, namely *the general direction and course of evolution is determined by the organism while environment serves merely as a stimulator, inhibitor or modifier.*

However, this contrast of organism and environment is by no means as simple and clear cut as is usually assumed. In many cases it is not only difficult to decide whether the differen-

tial cause of a character is one or the other of these, but it is even difficult to define what is meant by these two terms. The organism is not everything which lies within the skin and the environment everything outside of it, for much of the environment interpenetrates the organism without becoming a part of it. Moreover, there is an internal environment as well as an external one. Every organ, tissue or cell has its own environment in the surrounding body fluids and cells and this internal environment greatly influences the growth and development of every part. For example the development of many parts of the body depends upon internal secretions, such as enzymes or hormones, which act upon these parts as external environment acts upon the whole organism. At every stage in development the effects of external and internal environment are built into the organism and as one traces developed characters back to their earliest stages he realizes how difficult it is to separate these two sets of factors. And yet such a separation is at least *ideally* possible at every stage. We may say that the protoplasm represents the organismal factor, the non-protoplasmic substances the environmental. Possibly even protoplasm may be analyzed into a stimulating and a reacting portion, into environmental and formative substances, and this is indeed the view to which recent studies on the cellular basis of heredity have come. According to this view the protoplasm of the germ cells is not all equally concerned in inheritance, but a small portion of these cells, the chromatin, represents the hereditary organization, while the remaining portions act as innermost environment to this innermost organization. So far at least there is an actual basis in observation and experiment for separating hereditary and environmental factors, intrinsic and extrinsic causes, but whether such analyses can be extended to the different substances of which the chromatin is composed is at present unknown.

In this analysis into outer, inner and innermost environment and organization what are the distinguishing marks of the two sets of factors at every stage? Is it not that the intrinsic factor is in every instance the more specific one? In the same dish of water one egg will develop into a fish and another into a frog; the environment being the same in the two cases, the different results must be due to differences in the two eggs. Bathed in the same body fluids, one cell develops into muscle and another into nerve, owing to initial differences in the two cells. The same internal secretion in the blood affects different kinds

of cells and different parts of the body differently, thus the internal secretion of the sex gland leads to the development of the most diverse secondary sexual characters in different parts of the body, depending upon the specific nature of the cells acted upon. Within a single cell different chromosomes have different peculiarities both of structure and function; one may be short, another long; one may be a factor in determining sex another in determining color, etc., and yet all of these chromosomes are surrounded by a common cell substance and are bathed in common fluids. In each of these instances both intrinsic and extrinsic factors are indispensable and practically inseparable, but the intrinsic factors are more specific than the extrinsic ones.

(2) *Structure and Function.*—As environment may be analyzed into outer and inner, so for convenience and effectiveness of treatment organisms may be studied from the standpoint of their structures or their functions, but a living thing consists of both structures and functions and in reality these can not be separated from one another. Failure to recognize this is due perhaps to the fact that after the death of an organism its functions cease to exist, but its grosser structures, especially those composed of non-living or formed material, persist for a time and are often referred to as if they constituted the whole organism. But the active, living structure is the formative material or protoplasm of the cells and it is certain that the structure of this is not the same in the living and in the lifeless condition. Confusion on this subject would be avoided if, instead of thinking of the structures of organisms or of organs as a whole, composed as they are of much formed material as well as of protoplasm, we should have in mind the structures and functions of the living substance only. As long as life lasts the structures and functions of protoplasm are both present and inseparable; neither functionless living structures nor disembodied functions exist in organisms.[3] A living thing is a system in action; it is matter and energy. When the action wholly ceases the system is dead; when the contained energy is liberated from coal or from protoplasm the remaining matter ceases to be coal or protoplasm. Function and structure are two aspects of one thing, namely, life; they are the obverse and reverse sides of the same coin.

It would be unnecessary to mention these very elementary truths were it not for the fact that so many persons have failed

[3] Rudimentary organs or structures may seem to negative this statement, but while such structures may lose or change their original functions they can never be said to have no function.

to appreciate their significance. From the time of Aristotle and Plato to the present many students of organisms have maintained that function is the cause of structure, as if a disembodied function could form a body around itself, as if digestion, or exertion or vision could exist apart from material bodies and then proceed to form a stomach or kidney or eye. Lamarckians generally hold that modifications of functions or habits cause modifications of structures, as if the change in function preceded the change in structure. But there is good reason to believe that every change in function is accompanied by a corresponding change in structure, and *vice versa.* Because of the fact that functional changes are more easily seen than structural ones a change of function may occur without any visible change of structure; but this merely means that physiological indicators are more delicate than morphological ones. We know, for example, that there are actual structural differences between the egg of a worm and that of a starfish, but these structural differences were not discovered until very recently, whereas the differences in the developmental functions of these two eggs have been known from the first. There are many bacteria which can be distinguished only by their functions; for example one will liquefy agar, another will not, one will ferment dextrose another levulose, etc., and yet there is no reason to doubt that there are corresponding structural differences between these forms which have not yet been seen. Different chemical substances are often recognizable only by their reactions and yet every molecule probably has its distinctive structure.

To attribute growth, differentiation or evolution to function rather than to structure is due merely to lack of clear thinking. No doubt functional activity is a most important factor in growth and development; the used muscle grows in size and power, the unused one remains undeveloped or even atrophies. But in the use of a muscle both structure and function are involved; some *thing,* some *structure* contracts and as a result receives increased nutriment, and there is coincident growth both of structure and function. The long neck of the giraffe has been attributed to its habit of browsing on trees, the long neck of the clam to its habit of deep burial in the mud. It is pertinent to inquire where these animals got these habits and indeed what habit consists in and whether changes of habits may occur without corresponding, though perhaps very minute, changes of structure.

On the other hand the morphological view of development and evolution regards structure as preceding function; changes in function or habit are held to be caused by changes in structure. This opinion was once widely prevalent among morphologists and yet it has no more foundation in fact than the opposite view; the fact is that both the functional and the structural views of development and of evolution are partial views caused by a too narrow consideration of organisms from one or the other standpoint. So far as we know neither function nor structure stands in a fixed *causal* relation to the other though each conditions the other. Instead then of maintaining as most evolutionists have done that function is the cause of structure or that structure is the cause of function, the biologist who can see life and see it whole recognizes that neither of these aspects of an organism can exist by itself and that neither is the cause of the other. Function is not primary and structure secondary, but both change and evolve together.

GROWING PLANTS AS HEALTH-GIVING AGENTS

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EVERY one of refined tastes admires, if he does not actually have a tangible interest in, growing plants and flowers. Plants and flowers have in all ages been highly prized for their beauty and sweet perfume, and they are utilized as the chief objects of ornamental decoration on all occasions of public festivity. The introduction of these elaborate decorations occurred about the year 1867 (so says the *Court Journal*) when Sir Edward Scott gave the first grand floral ball in Grosvenor Square. The order to a well-known florist was that he (Sir Edward) wished his to be the handsomest ball of the season, and that he would place his house in the hands of the florist for three days to do as he liked, regardless of expense. The decorations caused a perfect furore, and it was the means of entirely revolutionizing the style of artistic decorations, not only in London, but also in every part of the United Kingdom, and, indeed, the whole of Europe and America. Moreover, this pleasant innovation had the happy effect of proving for all future time an incentive to the more general cultivation of plants. It it most gratifying to be able to note that the popularity of the practise has been growing until the present time (although too slowly), shedding a beneficent influence upon the progress of social refinement.

In the light of modern investigation, however, it would surely be rash to continue to hold the once popular view that the main purpose of plants and flowers is to appeal to our sense of the beautiful as displayed in their varied colors and graceful forms. This statement will become clear to the mind of the reader, provided we shall be able to make good our promise to show that while remarkable for their beauty they are not less remarkable for their effects upon human health and welfare, or, in other words, to establish new and vital relations between vegetable growth and the human family.

From the highest antiquity many important material relations of the vegetable kingdom to man's various needs have been

recognized. Further than to make mention of these as they affect either the productive resources of a region or the various domestic, artistic, and industrial purposes to which they are put, would be irrelevant to my present purpose. *Apropos* of the well-known metaphor "mother earth" it is to be recollected that the mineral kingdom is farther removed from us by one generation than the vegetable kingdom, hence we should naturally have a greater feeling of affection for the latter than the former.

It has been well said that the "fad" is an essential adjunct to every well-ordered life. Even the non-botanist will find a superficial study of wild flowers a satisfactory diversion for his vacation days and leisure hours. The plan offered in recent years by Chas. Lincoln Walton,[1] M.D., in his book styled "The Flower-Finder" is an excellent one for the purpose.

These days, the fact is pretty generally recognized, that all must work and all must play, or otherwise they grow stale or something worse. The largest measure of success in the application of this principle is to be attained by a study of needs of each individual, or classes of individuals. For example the mental worker not only requires systematic muscular activity in the open, but also relaxation for the mind, which must be diverted into other than the usual channels. For this large and important category the recreation exercise so easily obtainable in connection with the study and classification of wild flowers is to be earnestly encouraged and advised, as a means of meeting the mental phase of their requirements. The underlying principle involved quite properly assumes that a change of mind activities from the usual from time to time is essential to health and the highest degree of efficiency. Hence it is that the student of the classics or mathematics or a member of one of the three so-called learned professions—ministry, law and medicine—would find relief in the association with, and study of, growing plants and flowers. It is a splendid and effective method of inducing relaxation from the tension which will invariably tend to staleness if not in some way relieved. Indeed, this suggestion would be very helpful to all civilians.

Incidentally, the study of wild flowers necessitates considerable walking exercise. One can not ride and learn to recognize these beautiful specimens by the roadside and in field and forest, and after the love of exercise has been acquired, a brisk walk of a few miles, the while looking for and observing new

[1] "The Flower-Finder," J. B. Lippincott Co., by Chas. Lincoln Walton, M.D.

friends in the plant world, is a wonderful brace, stirring the blood, clearing the mind and strengthening the muscles,—in short it improves the vital, organic functions and prolongs life, not to speak of the enjoyment it affords. The method involves the observance of an important principle of hygiene, for in this pleasant pursuit of knowledge we incidentally acquire health, which is an asset of the greatest moment both from an individual and from a community viewpoint.

It is particularly desirable that a "fad" such as recommended above be adopted after the age of forty so as to ward off the degenerative diseases which are due to lack of physical exercise and overeating, and which have been steadily increasing in frequency of occurrence and mortality rate during the last quarter of a century. Again this statement applies especially to the dweller in cities, who has less chance than the dweller in the country to keep his body sound and vigorous. In this connection certain observations made by the late Theodore Roosevelt are pertinent:

> Any young lawyer, shopkeeper or clerk or shop-assistant can keep himself in good condition if he tries. Some of the best men who have ever served under me in the national guard and in my regiment were former clerks or floorwalkers. Why, Johnny Hayes, the marathon victor, and at one-time world champion, one of my valued friends and supporters, was a floorwalker in Bloomingdale's big department store. Surely with Johnny Hayes as an example, any young man in a city can hope to make his body all that a vigorous man's body should be.

The writer ventures to state that the sort of association with plant life recommended here would prove to be a revelation of a most agreeable character to the educated, and uneducated even,—in short to all whose attention has not been previously directed to its health-giving influence. He would especially urge heads of families to better the physical condition and in a measure secure the education of their children in this excellent manner. Moreover, this method of study would teach the young and rising generation to avoid temptations lurking in neighborhoods not conducive to good citizenship.

Perhaps one of the best fields in which to carry on these plant studies is offered by our public and secondary schools, as well as universities. The method would serve to widen the mental horizon of students and prove of decidedly stimulating interest apart from its great health-giving and moral value. These out-of-door educational and sanitary trips could be easily arranged for, by forming groups of pupils, in most towns and cities at least, and the tramps would be greatly enjoyed by all.

True it is that wherever found to be practicable students would soon show an ardent interest in this method of gaining instruction. The writer cherishes in memory wonderfully delightful trips of the sort.

It would be especially appropriate and convenient to arrange such expeditions for classes, or groups of older persons, during the summer vacation period and in connection with camp life. Their association with one another while enjoying intimate contact with elemental nature would lead to friendly ties, the while gaining useful information and healthful recreation. The method advocated would thus become a potent democratizing force.

There are also beneficial effects of growing plants and flowers of much importance due to their atmospheric influences. Until comparatively recent years (and in many quarters still) erroneous notions were entertained concerning the physiology of the vegetable kingdom. It must be confessed that the universal prejudice against plants and flowers in living and sleeping rooms which formerly existed is still exercising considerable sway over the more or less ignorant classes. There seems to be a deeply-rooted belief that plant respiration removes the oxygen from the surrounding atmosphere to such an extent as to be positively injurious when kept in living and sleeping rooms. They are also accused of giving off carbon dioxide to the same medium and thus rendering it deleterious when breathed. The carefully conducted experiments of Pettenkofer, however, have shown beyond all dispute, that the amount of oxygen absorbed from the air and the percentage of carbon dioxide exhaled as the result of plant breathing are too small to exert any appreciable effect. At all events, Pettenkofer's investigations indicate conclusively that no ill effects to the human race can be traced to the cultivation of plants and flowers indoors. It it strongly to be hoped that this statement will be given the widest publicity and also that it will be generally accepted. There are many lovers of growing house-plants and flowers, especially among women, but a not inconsiderable percentage of them do not cultivate these helpful and ornamental objects, owing to the unwarranted belief already mentioned that they are prejudicial to health.

It is an interesting and important fact that quite apart from the organic function of respiration, which proceeds uninterruptedly, and the harmlessness of which has been demonstrated, growing plants give off oxygen to the surrounding air in an

amount sufficient to improve this medium by increasing its oxidizing properties. The sanitary advantage thus offered is not appreciated to an extent commensurate with its significance. The writer's experiments, conducted long since (and later confirmed by French observers), showed conclusively that flowering plants as well as all odoriferous foliage, *e.g.*, pine trees, possess the peculiar power to convert the oxygen of the air into ozone. The far-reaching importance of this fact can be only grasped when it is recollected that it is the ozone contained in the air which oxidizes, or in other words burns up, the various impurities to be found in this life-giving medium. If this be correct no argument is needed to prove the high sanitary value of blooming and odoriferous plants, especially when grown indoors.

It must not be forgotten that the companionship afforded by growing plants and flowers in living rooms and close proximity to the home is soon highly appreciated by those who take up floriculture, hence here we find another excellent reason why these objects of beauty and social instincts should not be neglected. Unquestionably, the greater our intimacy with the habits, classification, modes of fertilization and functions of plants and flowers the greater will be our love for them and also our sense of appreciation of their hygienic and esthetic values.

There is another phase of the physiology of growing plants and trees which indicates clearly that they exert a beneficent effect upon the salubrity of the surrounding air. I refer to the function of transpiration, or the evaporation of moisture from their leaf surfaces. The actual amount of water thus returned to the atmosphere is far in excess of what persons versed in vegetable physiology had supposed, when they came to note the actual results of carefully conducted experiments by the writer and others.[2] It has also been shown that soft, and thin-leaved plants show the most active rate of transpiration, and such as possess foliage of this sort should be selected so far as practical in making a choice for indoor cultivation. It has been computed that the Washington Elm at Cambridge, Mass., with its 200,000 square feet of leaf surfaces in twelve hours of clear weather transpires not less than seven and three fourths tons of vapor. Experiment clearly indicates that this function is a potent factor in maintaining a proper degree of moisture in the air, when plants are grown indoors. Verily, to plants may be assigned honorable rank as natural and efficient atomizers, making their influence everywhere felt beyond question.

[2] Vide "House-Plants as Sanitary Agents," by the writer, p. 93.

In this connection it should be borne in mind that the atmosphere of our artificially heated homes—and this is especially true of those all too numerous houses warmed by dry-air furnaces—is decidedly lacking in moisture. House-plants, rightly utilized, fulfil an important hygienic indication by adding moisture, and that freely, to these unwholesomely dry, usually overheated, and insanitary homes.

There can be no doubt that the public is taking more and more seriously, and rightly so, sanitary measures of all kinds. Certain deeply-rooted prejudices which are without foundation, however, can only be eradiated by time and oft-repeated demonstration. Perhaps one of the erroneous popular notions most tenaciously adhered to has been that house-plants are prejudicial to health, especially when grown in sleeping rooms, because of the ancient and fixed belief that they give off carbon dioxide during the night, rendering the bedroom unfit for breathing purposes during sleep. This notion has been successfully exploded, and, on the other hand, it has been clearly shown that this substance is constantly exhaled, that is to say by day as well as by night (plant-breathing), but in amount too minute to affect human health unfavorably. In view of the foregoing facts, growing house-plants and flowers which have considerable hygienic value owing to other functions, previously discussed, may be freely cultivated indoors, including bedchambers. Indeed among the numerous forms of diversion at our command, the practise of floriculture, which is neither difficult nor costly, should be held to be one of the foremost.

Here brief reference to two climatic influences of forest growth may be made. In the first place, trees possessing odorous foliage or flowers, especially pine grove forests, as was pointed out above in connection with plants grown indoors, increase the ozone or normal purifying agent of the external air. Again from facts developed as the result of experimentation, there can be little doubt but that forests tend to augment and maintain an equal degree of atmospheric humidity in their vicinity and in so far as this influence extends must they likewise tend to abridge the diurnal range of temperature—a matter of greater importance to the race than seasonal variations of temperature.

It has been well said by a recent writer, that a home which does not reflect the profusion of the outdoor season in the form of flowers in summer, is "as devoid of character and charm as a man without a necktie." For this purpose both cultivated and

wild flowers in vases solve the problem. But if the desired object is to do something in the world to make men better, healthier and fitter for the duties of this life, we should advocate the cultivation of house-plants so that the people could enjoy their sanitary advantages as well as their beauty and delightful companionship. The thorough and searching investigations of the recent past have yielded results which should for all time afford pleasure and material benefits to all lovers of growing plants and flowers.

Moreover, association with these living objects develops an affinity which often results in genuine friendship. Indeed, contact with elemental nature has come to be recognized as a socializing and relaxing force of much importance. It will, however, require our incessant efforts at diffusion of a knowledge of this fact before it will be generally utilized or acted upon by the masses. It is high time to abandon the view so long dominant that an antagonism due to certain plant functions exists between the animal and vegetable kingdoms. It is equally in order to spread the gospel of health as it relates to the notable sanitary influences of growing vegetation, both indoors and out-of-doors and thereby encourage re-forestation and the cultivation of house-plants.

The only possible objection to growing house-plants is to be found in the heavy sweet odors given off by a few species, *e.g.*, irises and roses. These may give rise to headaches and other unpleasant symptoms in certain persons, but it is not necessary to include such examples in the selection of a group of plants for indoor cultivation.

Those who know what hygienic measures of this sort can mean to a community should carry the message to others who are less fortunate. The result of such a propaganda, we may be assured, would be an improved general state of health and a greater measure of human happiness. It is really inspiring to see the enthusiasm with which the men on whom the well-being of the race largely depends endeavor to make the fruits of their unselfish labors available by the dissemination of the needed information for health and happiness building. In growing plants and flowers, we have hygienic agents in such form as that their practical use need in no sense be circumscribed. They can be cultivated by rich and poor alike and hence floriculture should reach even the remote and obscure quarters of the earth. It would be an excellent and certain way of making home life everywhere increasingly more beautiful and healthful.

THE MICROSCOPIC IDENTIFICATION OF COMMERCIAL FUR HAIRS

By Dr. LEON AUGUSTUS HAUSMAN

(From the Zoological Laboratory, Cornell University)

THE use of the furry pelts of animals as articles of clothing is of very ancient origin, and probably contemporaneous with the beginnings of the manufacture of flint artifacts and war clubs. Its use as a decoration for the body, began presumably, somewhat later. The oriental peoples, as early as 2000 B.C. were using furs, not only as a protection against cold, but also as articles of luxury, and Herodotus mentions their use by other ancient peoples. Furs were much prized by the Romans, particularly during the later days of the empire, and the Saracens also made extensive use of them. It was from this latter source that the Crusaders first introduced furs into Europe, where they met with immediate favor, particularly among the nobles and clergy, where they were used in ceremonial regalia. The popularity of furs early rose to such a pitch that, in England and France, sumptuary edicts were issued against their unrestricted use, which did little, however, to check the increasing demand. It was to meet this demand that those hardy pioneers and explorers, the trappers and fur traders, penetrated far into the wildnernesses of the then unknown northern portions of North America, and established there the trading stations which later came to play such important rôles in the spread of the white man in America.

The use of furs as necessary articles of clothing as well as for ornamental purposes, is as great to-day as ever, and indeed during the past several years seems to have increased the severity of its demands. Certain mammals are being rapidly reduced in numbers, if not threatened with extinction; and certain furs are becoming rare and consequently expensive. Hence there arises the necessity for some methods whereby the species from which any given fur was obtained can be indubitably determined. For it is possible to remodel and rename furs, that is, so to clip, dye and pull them, that their original appearance is altered to such an extent that they may be sold under names not their own. Furs so remodelled may be sold

under the names of furs much superior in wearing quality or in warmth.

Thus the pelts of animals from warmer zones such as the woodchuck (marmot), opossum, Australian opossum, raccoon, weasel, Tartar pony, Manchurian dog, and certain monkeys are worked up by fur dressers into articles but little resembling their originals and sold under other names, usually under the names of animals of northern latitudes. Such furs are inferior to those from colder climates in suppleness and durability of leather, denseness and silkiness of under, or fur-hair, fullness of over- or protective hair, and because dyed, brittle and less durable in general. One of the most durable of all furs is that of the sea otter (*Latax lutris*). Considering this to be represented by 100, the relative durability of some common furs, when used with the fur outside (not for linings), is as follows:[1]

Species	Durability (Otter = 100)
1. Beaver	90
2. Bear, black or brown	94
3. Chinchilla	15
4. Ermine	25
5. Fox, natural	40
6. Fox, dyed	20–25
7. Goat	15
8. Hare	05
9. Kolinsky	25
10. Leopard	75
11. Lynx	25
12. Marten (skunk)	70
13. Mink, natural	70
14. Mink, dyed	35
15. Mole	07
16. Muskrat	45
17. Nutria (Coypu rat), plucked	25
18. Otter, sea	100
19. Otter, inland	100
20. Opossum	37
21. Rabbit	05
22. Raccoon, natural	65
23. Raccoon, dyed	50
24. Sable	60
25. Seal, hair	80
26. Seal, fur	80
27. Squirrel, gray	20–25
28. Wolf	50
29. Wolverene	100

[1] Modified, from Peterson, "The Fur Trade and Fur Bearing Animals," Buffalo, 1914.

The misnaming of furs offered for sale in England reached, several years ago, such magnitude that the London Chamber of Commerce gave notice that misleading names were not to be employed, and that offenders were liable to prosecution. More definite legislation than now exists ought also to be had in this country. The following table[2] lists some of the best known furs, and their usual misnomers.

Species	Altered and Sold as
1. American sable	Russian sable
2. Fitch, dyed	Sable
3. Goat, dyed	Bear, of various kinds
4. Hare, dyed	Sable or fox
5. Kid	Lamb
6. Woodchuck (marmot), dyed	Mink, sable, skunk
7. Mink, dyed	Sable
8. Muskrat (musquash), dyed	Mink, sable
9. Muskrat (musquash), pulled and dyed	Seal, electric seal, Hudson Bay Seal, Red River seal
10. Nutria (Coypu rat), pulled and dyed	Seal, electric seal, Hudson Bay seal, Red River seal
11. Nutria (Coypu rat), pulled, naturall	Beaver, otter
12. Opossum, sheared and dyed	Beaver
13. Otter, pulled and dyed	Seal of various kinds
14. Rabbit, dyed	Sable
15. Rabbit, sheared and dyed	Seal, electric seal, Hudson Bay seal, Red River seal, musquash
16. Rabbit, white	Ermine
17. Rabbit, white, dyed	Chinchilla
18. Kangaroo (wallaby), various species, dyed	Skunk (marten)
19. Hare, white	Fox
20. Goat, dyed	Leopard

Up to the present time no very dependable series of criteria for the indubitable identification of mammal hairs was to be had. In a recent paper on the microscopic structure of mammalian hair[3] the author has pointed out that the constant characteristics of certain microscopic elements in the structure of the hair shaft are significant from several zoological viewpoints. That the results of the application of these criteria for the identification of commercial fur hairs may be of practical value

[2] Modified, from Jones, "Fur Farming in Canada" (Canada Commission of Conservation), Ottawa, 1914.

[3] Hausman, L. A., "A Micrological Investigation of the Definitive Hair Structure of the Mammalia, with Especial Reference to the Monotremata" (in press).

to the general public as well, it is the object of this paper to point out.

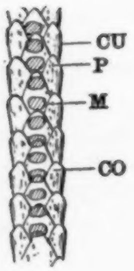
In order to appreciate the nature of the microscopic elements of the hair structure used in identification, it will be helpful to pass briefly in review the structure of the typical mammalian hair. Hairs arise from the bases of relatively deep pits in the epidermis, or outer layer of the skin, known as follicles, and push upward, being added to from the base, in a rod-like growth, of circular or elliptical cross section, and are composed of four elements (Fig. 1): (1) the *medulla* (*M*), or pith, consisting of many superimposed cells or chambers, which may be either separate or massed, (2) the *cortex* (*CO*), or shell, surrounding the medulla, of tough, horny, homogeneous texture and hyaline appearance, (3) the *pigment granules* (*P*), to which the color of the hair is primarily due, scattered about within the corticular substance, and (4) the *cuticle* (*CU*), or outermost integument of the hair shaft, lying upon the cortex and composed of plate-like scales, imbricated somewhat like the shingles on a roof. It is the form and interrelationships of these various structural elements, together with the diameter of the hair shaft, which form the series of determinative criteria to which reference has been made.

Medullas occur in four distinct forms: (1) the *discontinuous medulla,* as in the hair of the duck bill, or platypus, Fig. 27; (2) the *continuous medulla,* as in the hair of the red fox, Fig. 8; (3) the *interrupted medulla,* as in the hair of the hair seal, Fig. 13, which is a type intermediate between the first two; and (4) the *fragmental medulla,* as in the hair of the European otter, Fig. 11. It will be noted, furthermore, that the hair of some species lacks the medulla altogether.

The cortex, since it is usually of homogeneous structure, shows few or no compositional characteristics, and when used in description is merely measured as to thickness between the cuticle and medulla.

The pigment granules when present, are usually of characteristic form and distribution, and can often be used for one of the criteria for identification.

The elements, however, which presents the most readily usable and definite characteristics, are the scales of the cuticle. They fall into two great formal groups: (1) the *imbricate interrupted* type, those which lie singly imbricated about the hair shaft, like shingles on a roof, as in the hair of the Coypu rat, Fig. 18; and (2) the *imbricate coronal* type, those which



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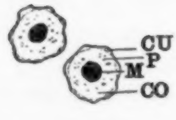

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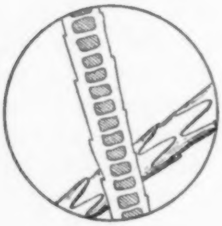

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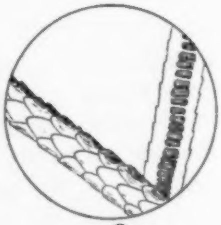

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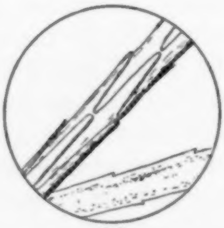

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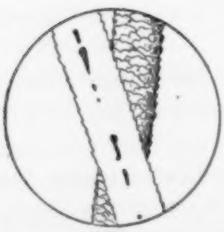

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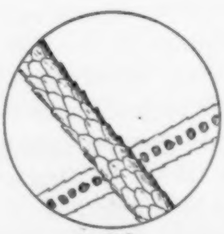

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encircle the hair shaft as continuous bands, as in the hair of the ermine, Fig. 6. Of these two types there are a multitude of intricate variations.

The hair covering of most mammals consists of two kinds of hair; a soft, thick, under hair, called the *fur hair*, and a longer, stouter hair, which overlies the fur hair, termed the *protective hair*. In commerce the names under hair and over hair are usually employed. Microscopic examination of the structures used for identification may be made, as is sometimes necessary, of both these kinds of hair. It is usually sufficient, however, to subject only the fur hair to examination.

The preparation of hair for ordinary examination is not laborious. Several hair shafts are taken, and washed in a solution composed of equal parts of 95 per cent. alcohol and ether, to remove any oily matter from their surfaces. They are then transferred to a clean glass slide; covered with a cover glass, and allowed to stand in a current of warm air until thoroughly dry. Examination can now be made directly, using the 8 x ocular and the 16 mm. and 4 mm. objectives. This simple treat-

FIG. 1. IDEAL GENERALIZED MAMMAL HAIR, TO SHOW THE STRUCTURE. *CU*, cuticle; *CO*, cortex; *M*, medulla; *P*, pigment granules.

FIG. 2. TRANSVERSE SECTION THROUGH TWO HAIR SHAFTS FROM THE DUCK BILL, OR *Platypus*. *CU*, cuticle; *CO*, cortex; *M*, medulla; *P*, pigment granules.

ORDER FERÆ (THE CARNIVORA)

FIG. 3. Badger (*Taxidea americana*), 57.
FIG. 4. Black bear (*Ursinus americanus*), various varieties of, 27.
European brown bear (*Ursus arctos*).
FIG. 5. Civet (*Arctogalidia fusca*), 21.
Domestic cat (*Felis catus*).
Wild cat (several species).
FIG. 6. Ermine (*Putorius erminea*), 17.
FIG. 7. Fitch (*Mustela putorius*), 18.
FIG. 8. Red fox (*Vulpes pennsylvanicus*), with its various varieties, 19.
Genet (*Viverra genetta*).
Kolinsky (see Siberian mink).
Leopard (*Felis pardus*).
FIG. 9. Canada lynx (*Lynx canadensis*), 19.
Marten (see skunk).
Pine marten (*Mustela martes*).
Stone marten (*Mustela foina*).
FIG. 10. Mink (*Putorius vison*), with its various varieties, 11.
Siberian mink (*Mustela sibirica*).
American otter (*Lutra canadensis*).
FIG. 11. European otter (*Lutra vulgaris*), 10.
Sea otter (*Latax lutris*).
FIG. 12. Raccoon (*Procyon lotor*), 20.
American sable (*Mustela americana*).
Russian sable (*Mustela zibellina*).
Fur seal (*Callhorinus ursinus*), and other species.
FIG. 13. Hair seal (*Otaria jubata*), 105. Sea lions of the genera *Eumentopias*, and *Zalophus* are also used.
FIG. 14. Skunk (*Mephitis mephitica*), 26.
FIG. 15. Wolverene (*Gulo luscus*), 25.


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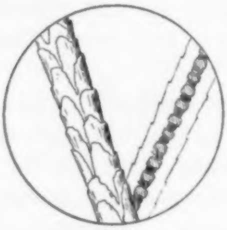
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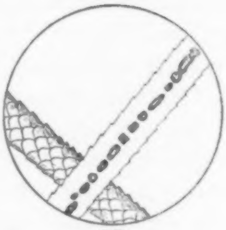
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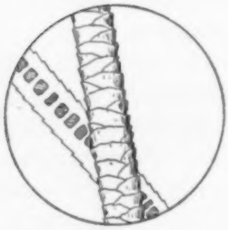
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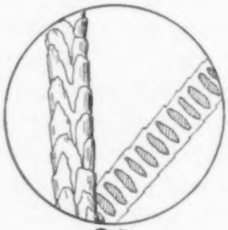
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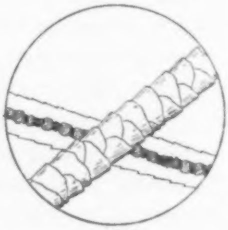
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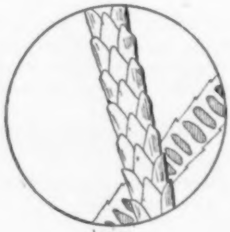
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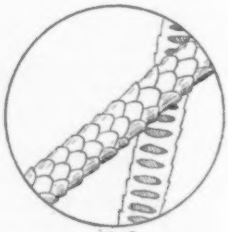
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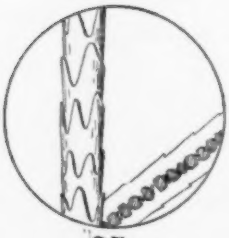
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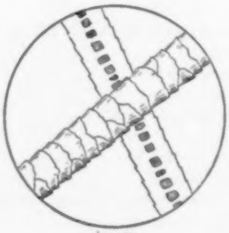
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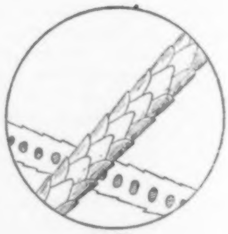
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ORDER GLIRES (THE RODENTS)

FIG. 16. American beaver (*Castor canadensis*), 18.
European beaver (*Castor fiber*).
FIG. 17. Chinchilla (*Chinchilla lanigera*), 16.
FIG. 18. Coypu rat, or nutria (*Myocastor coypus*), 11.
Cony (see rabbit).
Hare (*Lepus americanus virginianus*) and other species.
Marmot (see woodchuck).
Nutria (see Coypu rat).

ment answers very well for those hairs whose structural elements are large and prominent, such as those of the European otter, Fig. 11, and of the American beaver, Fig. 16. In other cases the hairs must be washed in the ether-alcohol as before, and then dipped with forceps into a 95 per cent. alcoholic solution of gentian violet, methyl blue, methyl violet, Bismarck brown, or safranin, of a degree of color depth which must be empirically determined for the best results with each different species of hair. This treatment renders clear the outlines of the individual scales. However, even this manipulation fails to reveal the contour of the scales of certain hairs, and various other methods devised by the writer, too lengthy for description here, must be called into service. Treatment with caustics, such as caustic soda or potash; or with acids, such as nitric or hydrochloric, which have sometimes been recommended, distorts the scales and thereby renders them valueless for delicate determinative purposes.

The treatments used to render the cuticular scales visible, obscure the medulla, hence other methods are necessary to bring into prominence this element of the hair structure. The simplest and most generally useful of these is to mount the hair on a slide in some one of the light oils used in micrological work, such as oil of cloves, oil of bergamont, oil of cedar, etc., after having washed the hair, as before, in the ether-alcohol solution. With some few hairs it is satisfactory to use clear water as the mounting medium. The methods used to bring the medulla into

FIG. 19. American gray squirrel (*Sciurus carolinensis*), 18.
Siberian gray squirrel (*Sciurus vulgaris*).
FIG. 20. Rabbit (*Lepus nutalli malurus*), and other species, 17.
FIG. 21. Woodchuck (*Arctomys monax*), 22.
FIG. 22. Muskrat (*Fiber zibethecus*), 17.

ORDER UNGULATA (THE HOOFED MAMMALS)

Domestic goat (*Capra hircus*).
Pony, or domestic horse.
Astrachan (*Ovis aries*), and its varieties.

ORDER INSECTIVORA (THE MOLES, SHREWS, ETC.)

FIG. 23. European mole (*Talpa europea*), 17.
FIG. 24. American mole (*Scalops aquaticus*), 17.

ORDER MARSUPIALIA (THE POUCHED MAMMALS)

FIG. 25. Koala (*Phascolarctos cinereus*), 22.
FIG. 26. Opossum (*Didelphys virginiana*), 37.
Rock wallaby (*Petrogala pencillata*).
Yellow wallaby (*Petrogale xanthopus*).

ORDER MONOTREMATA (THE EGG-LAYING MAMMALS)

FIG. 27. Duck bill, or platypus (*Ornithorhynchus anatinus*), 8.

clear visibility are also useful for rendering plain the pigment granules.

For the measurements of the diameter of the hair shaft, the ocular micrometer is perhaps the most satisfactory. Since, in any given tuft of hairs, there is considerable variation in the diameters of the individual shafts, the average of many measurements should be taken.

It was sometimes, though fortunately not frequently, found necessary to prepare transverse sections of the hair shafts, to determine more fully the contour of the medulla. Fig. 2 shows two shafts of the fur hair of the duck bill, or platypus, sectioned in this way.

In the following classified list are enumerated those mammals whose pelages are the most extensively used in the fur trade. The numbers against some of these, which are the most common, are the numbers of the figures wherein is shown the microscopic appearance of the fur hair. In each figure two hair shafts are depicted, one treated to show the cuticular scales; the other to show the medulla. The hair shafts are not drawn to scale; where there is so great variation in diameters this is not practicable. Hence, following the name of each species whose hair is figured, appears the average diameter of the shafts of the fur hairs, expressed in micra.[4]

[4] One micron 1/1,000 of a millimeter, or circa 1/254,000 inch.

D

THE REFLECTION OF LIGHT BY GRAVITATION AND THE EINSTEIN THEORY OF RELATIVITY[1]

By SIR JOSEPH THOMPSON,

PRESIDENT OF THE ROYAL SOCIETY IN THE CHAIR.

SIR FRANK DYSON, *The Astronomer Royal:*

The purpose of the expedition was to determine whether any displacement is caused to a ray of light by the gravitational field of the sun, and, if so, the amount of the displacement. Einstein's theory predicted a displacement varying inversely as the distance of the ray from the sun's center, amounting to 1″.75 for a star seen just grazing the sun. His theory or law of gravitation had already explained the movement of the perihelion of Mercury—long an outstanding problem for dynamical astronomy—and it was desirable to apply a further test to it. Many people considered it quite likely that, even if Einstein's conclusion was not confirmed, we should get half his computed deflection for a beam—this other result being the deflection of a particle moving past the sun with the velocity of light.

The effect of the predicted gravitational bending of the ray of light is to throw the star away from the sun. In measuring the positions of the stars on a photograph to test this displacement, difficulties at once arise about the scale of the photograph. The determination of the scale depends largely upon the outer stars on the plate, while the Einstein effect causes its largest discrepancy on the inner stars nearer the sun, so that it is quite possible to discriminate between the two causes which affect the star's position.

Previous eclipse photographs are generally unsuitable for evidence bearing on the point, as they are either on too large a scale showing too few stars on the plate or else on too small a scale to provide the delicate test with sufficient accuracy. The plates secured at Sfax in 1905 with one of the astrographic objectives used for the International *Carte du Ciel* seemed of suitable scale. Examination of them failed to give a definite result, but showed that this instrument was well suited to our

[1] From the report in *The Observatory*, of the Joint Eclipse Meeting of the Royal Society and the Royal Astronomical Society, November 6, 1919.

problem. A study of the conditions of the 1919 eclipse showed that the sun would be very favorably placed among a group of bright stars—in fact, it would be in the most favorable possible position. A study of the conditions at various points on the path of the eclipse, in which Mr. Hinks helped us, pointed to Sobral, in Brazil, and Principe, an island off the West Coast of Africa, as the most favorable stations, and the eclipse committee decided to send out expeditions to these two places if the war conditions allowed. Professor Turner, of the Oxford University Observatory, most kindly loaned the object-glass of the Oxford astrographic telescope, and the arrangements for mounting this and the Greenwich objective were pushed forward at Greenwich as hard as the reduced staff permitted. Father Cortie further suggested the use of a 4-inch lens of 19 ft. focal length belonging to the Royal Irish Academy. The instruments were assembled at Greenwich largely under Mr. Davidson's supervision, and all was ready in time for the observers to start from England in March.

The Greenwich party, Dr. Crommelin and Mr. Davidson reached Brazil in ample time to prepare for the eclipse, and the usual preliminary focussing by photographing stellar fields was carried out. The day of the eclipse opened cloudy, but cleared later, and the observations were carried out with almost complete success. With the astrographic telescope Mr. Davidson secured 15 out of 18 photographs showing the required stellar images. Totality lasted 6 minutes, and the average exposure of the plates was 5 to 6 seconds. Dr. Crommelin with the other lens had 7 successful plates out of 8. The unsuccessful plates were spoiled for this purpose by clouds, but show the remarkable prominence very well.

When the plates were developed the astrographic images were found to be out of focus. This is attributed to the effect of the sun's heat on the coelostat mirror. The images were fuzzy and quite different from those on the check-plates secured at night before and after the eclipse. Fortunately the mirror which fed the 4-inch lens was not affected, and the star-images secured with this lens were good and similar to those got by the night-plates. The observers stayed on in Brazil until July to secure the field in the night sky at the altitude of the eclipse epoch and under identical instrumental conditions.

The plates were measured at Greenwich immediately after the observers' return. Each plate was measured twice over by Messrs. Davidson and Furner, and I am satisfied that such faults as lie in the results are in the plates themselves and not

in the measures. The figures obtained may be briefly summarized as follows: The astrographic plates gave 0".97 for the displacement at the limb when the scale-value was determined from the plates themselves, and 1".40 when the scale-value was assumed from the check-plates. But the much better plates gave for the displacement at the limb 1".98, Einstein's predicted value being 1".75. Further, for these plates the agreement between individual stars was all that could be expected. The following table gives the deflections observed compared with those predicted by Einstein's theory:

No. of Star	Displacement in R.A.		Displacement in Dec.	
	Observed	Calculated	Observed	Calculated
11	− 0".19	− 0".22	+ 0".16	+ 0.02
5	− 0.29	− 0.31	− 0.46	− 0.43
4	− 0.11	− 0.10	+ 0.83	+ 0.74
3	− 0.20	− 0.12	+ 1.00	+ 0.87
6	− 0.10	+ 0.04	+ 0.57	+ 0.40
10	− 0.08	+ 0.09	+ 0.35	+ 0.32
2	+ 0.95	+ 0.85	− 0.27	− 0.09

After a careful study of the plates I am prepared to say that there can be no doubt that they confirm Einstein's prediction. A very definite result has been obtained that light is deflected in accordance with Einstein's law of gravitation.

DR. A. C. CROMMELIN, *Assistant Astronomer Royal:*

I have not much to add to what the Astronomer Royal has said, but I should like to say what a great debt we owe to the Brazilian Government for the immense help they gave us. Dr. Morize, the Brazilian national astronomer, gave all possible assistance; he had made a preliminary visit to Sobral a month before, when he made arrangements for our accommodation and also for supplying us with all the labor that we required—porters, bricklayers and carpenters were all freely put at our service. Members of Dr. Morize's staff helped by supplying us with chronometer errors and meteorological data. We were much indebted to Col. Vicente Saboya, the deputy for Sobral, who put his house at our disposal, with a permanent water-supply—no small boon in a time of drought, and of great importance in the photographic work. Dr. Locadio Aranjo, our interpreter, gave us invaluable help at every point, clearly explaining to the workmen our complicated demands, and calling the seconds for us at the eclipse. We were also indebted to the Booth Steamship Company for much help in dealing with our

heavy baggage. They made arrangements with the local companies to forward it free of charge from Para to Camocim and thence to Sobral.

We should also thank the Sobral municipal authorities, who allowed us to encamp on the race-course and kept the public outside during the eclipse.

With regard to the bad focus of the plates taken with the astrographic during totality, we can only ascribe this to a change of curvature of the cœlostat mirror, due to the sun's heat; for the focus was good on the stars two days before the eclipse and again on the check-plates taken during July. The small cœlostat used with the 4-inch lens did not suffer from deformation, the images of stars during totality being of the same character as those on the check-plates; this increased the weight of the determination with that instrument. With regard to the July plates, we found that exposure was possible up to 25 minutes before sunrise, when the sky was of about the same brightness as during totality. $39\frac{1}{2}°$ was the greatest altitude of the field on the check-plates, as compared with 44° at the eclipse.

PROFESSOR A. S. EDDINGTON, *Royal Observatory:*

Mr. Cottingham and I left the other observers at Madeira and arrived at Principe on April 23. We were most kindly received at Principe by Sr. Carneiro. He also supplied us with all the labor and materials we needed, and we established our station at Sundy, the headquarters of his plantation, on the northwest side of the island. The island of Principe is about 10 miles long by 4 miles wide. We soon realized that the prospects of a clear sky at the end of May were not very good. Not even a heavy thunderstorm on the morning of the eclipse, three weeks after the end of the wet season, saved the situation. The sky was completely cloudy at first contact, but about half an hour before totality we began to see glimpses of the sun's crescent through the clouds. We carried out our program exactly as arranged, and the sky must have been a little clearer towards the end of totality. Of the 16 plates taken during the five minutes of totality the first 10 showed no stars at all; of the later plates two showed five stars each, from which a result could be obtained. Comparing them with the check-plates secured at Oxford before we went out, we obtained as the final result from the two plates for the value of the displacement at the limb $1''.6 \pm 0''.3$. The p.e. was determined from the residuals of individual stars. This result supports the figures obtained at Sobral.

There was one important difference in our data—we were unable to stay to take check-photographs of the field. As our eclipse took place in the afternoon, we should have had to wait some months longer than the Sobral observers to get the comparison-plates under the same conditions. We, however, took another field of stars for a check and compared our photographs with the Oxford plates of the same field to see whether a similar reduction gave evidence of any displacement corresponding to that found on the eclipse-plates. We got a very small value for the displacement on these check-plates, leading to the conclusion that the larger quantities found on the eclipse-plates could only be due to the presence of the sun in the field. We also used these check-plates to determine the difference of scale of the photographs at Oxford and Principe, and used that scale for working up the eclipse-plates. This was a great help in making the most of a small amount of material. A difference might have arisen for reasons of temperature changes; but the temperature at Principe is very uniform day and night—in fact, there was not 4° difference during the whole time we were at Principe, and we were there both for the hot and the cold season. Again, in one way we were helped by the clouds that at the time seemed so serious an obstacle; the sun's rays could not seriously affect the mirror by heating it, as seems to have happened at Sobral.

I will pass now to a few words on the meaning of the result. It points to the larger of the two possible values of the deflection. The simplest interpretation of the bending of the ray is to consider it as an effect of the weight of light. We know that momentum is carried along on the path of a beam of light. Gravity in acting creates momentum in a direction different to that of the path of the ray and so causes it to bend. For the half-effect we have to assume that gravity obeys Newton's law; for the full effect which has been obtained we must assume that gravity obeys the new law proposed by Einstein. This is one of the most crucial tests between Newton's law and the proposed new law. Einstein's law had already indicated a perturbation, causing the orbit of Mercury to revolve. That confirms it for relatively small velocities. Going to the limit, where the speed is that of light, the perturbation is increased in such a way as to double the curvature of the path, and this is now confirmed.

This effect may be taken as proving Einstein's *law* rather than his *theory*. It is not affected by the failure to detect the displacement of Fraunhofer lines on the sun. If this latter failure is confirmed it will not affect Einstein's law of gravita-

tion, but it will affect the views on which the law was arrived at. The law is right, though the fundamental ideas underlying it may yet be questioned.

The difference of the two laws may be expressed analytically as follows: Any particle or light-pulse moves so that the integral of ds between two points of its path (in four dimensions) is stationary where

$$ds^2 = -(1-2m/r)^{-1}dr^2 - r^2d\theta^2 + (1-2m/r)dt^2 \text{ (Einstein's law)}.$$
$$ds^2 = -dr^2 - r^2d\theta^2 + (1-2m/r)dt^2 \text{ (Newton's law)}.$$

These expressions are in polar coordinates for a particle of gravitational mass m. I think the second expression may be accepted as corresponding to Newton's law—at any rate, it gives no motion of perihelion of Mercury and the half-deflection of light. What we have established is the necessity for the factor multiplying dr^2.

One further point must be touched upon. Are we to attribute the displacement to the gravitational field and not to refracting matter round the sun? The refractive index required to produce the result at a distance of 15′ from the sun would be that given by gases at a pressure of 1/60 to 1/200 of an atmosphere. This is of too great a density considering the depth through which the light would have to pass.

SIR JOSEPH THOMSON, *President of the Royal Society:*

I now call for discussion on this momentous communication. If the results obtained had been only that light was affected by gravitation, it would have been of the greatest importance. Newton did, in fact, suggest this very point in the first query in his "Optics," and his suggestion would presumably have led to the half-value. But this result is not an isolated one; it is part of a whole continent of scientific ideas affecting the most fundamental concepts of physics. It is difficult for the audience to weigh fully the meaning of the figures that have been put before us, but the Astronomer Royal and Professor Eddington have studied the material carefully, and they regard the evidence as decisively in favor of the larger value for the displacement. This is the most important result obtained in connection with the theory of gravitation since Newton's day, and it is fitting that it should be announced at a meeting of the society so closely connected with him.

The difference between the laws of gravitation of Einstein and Newton come only in special cases. The real interest of

Einstein's theory lies not so much in his results as in the method by which he gets them. If his theory is right, it makes us take an entirely new view of gravitation. If it is sustained that Einstein's reasoning holds good—and it has survived two very severe tests in connection with the perihelion of Mercury and the present eclipse—then it is the result of one of the highest achievements of human thought. The weak point in the theory is the great difficulty in expressing it. It would seem that no one can understand the new law of gravitation without a thorough knowledge of the theory of invariants and of the calculus of variations.

One other point of physical interest arises from this discussion. Light is deflected in passing near large bodies of matter. This involves alterations in the electric and magnetic field. This, again, implies the existence of electric and magnetic forces outside matter—forces at present unknown, though some idea of their nature may be got from the results of this expedition.

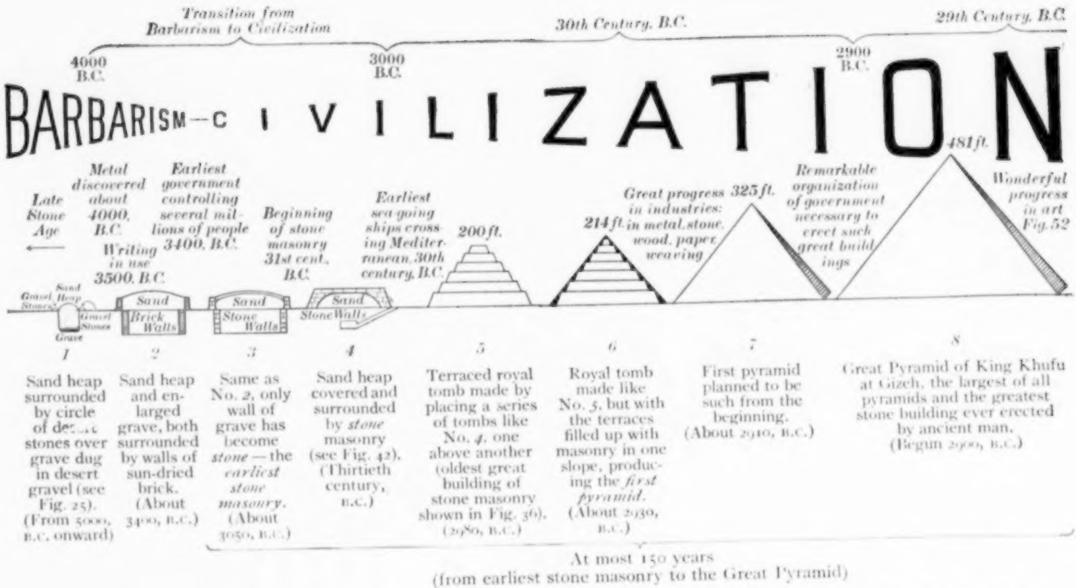


FIG. 65. DIAGRAM SHOWING THE EVOLUTION OF THE EGYPTIAN TOMB FROM THE SAND-HEAP TO THE PYRAMID. From the author's "Ancient Times," by permission of Ginn & Co.)

The body of the early Egyptian peasant lay at the bottom of a grave above which was a low heap of sand surrounded by a circle of rough desert stones to keep the sand in place. No. 1, above, shows this grave, cut down through the middle to expose the inside with the sand heap above it. In nos. 2, 3 and 4 we see the later tombs, also cut down through to expose the inside. They show how the circle of stones around the sand heap was slowly improved till it became real walls, first of brick (no. 2) and then of stone masonry (no. 3) enveloping the whole tomb, with the old sand heap still in the inside. Tombs like no. 4 were then placed one above the other, producing a tapering terraced building (no. 5) which was soon improved until it became a pyramid (no. 6). Thus the sand heap and its circle of stones were the germ out of which the mighty pyramids grew in the course of fifteen or twenty centuries. Notice how this wonderful growth in the art of building began with the sand heap in the barbarism of the Late Stone Age and thus carries us over from barbarism to civilization in the thousand years from 4000 to 3000 B.C. This great art of building was itself one of the things which marked the entrance upon civilization, and architecture passed from the earliest example of stone masonry to the Great Pyramid in only one hundred and fifty years. But incoming civilization was not marked only by progress in the art of building. The remarks inserted above, over the tombs and pyramids, suggest to us some of the other important achievements which helped to bring in and develop civilization, like the discovery of metal and the invention of writing, followed by the earliest government of a large population, the earliest seagoing ships, great progress in industries, and a remarkable development in art. We now see how the pyramids and their predecessors stand like milestones marking the long road by which man passed from barbarism to a highly developed civilization.

THE ORIGINS OF CIVILIZATION[1]

By Professor JAMES HENRY BREASTED

THE UNIVERSITY OF CHICAGO

LECTURE TWO

THE EARLIEST CIVILIZATION AND ITS TRANSITION TO EUROPE

We have seen how the Stone Age hunters of the Nile gradually gained agriculture, domestic animals, metal, writing and industries, and leaving behind the men of the Mediterranean world elsewhere, in the thousand years between 4000 and 3000 B.C. transformed their northeast African game preserve into the first great state, regulated and controlled by a highly organized administration. This progress and especially its culmination in the thirtieth century B.C. is graphically visualized in the diagram in Fig. 65.

No. 1 at the extreme left end represents the pit grave, the only type of burial known until nearly 4000 B.C., which we saw in the first discussion. Surmounted by a low mound of sand, with perhaps a circle of stones around it, this earliest burial was the germ of the pyramid of stone masonry. We can trace the development from stage to stage—a development slow and gradual as civilization arose between 4000 and 3000 B.C., but quickening with surprising swiftness after passing 3000, that is during the thirtieth century, between 3000 and 2900 B.C. Hardly more than a generation before this thirtieth century the first example of hewn stone masonry was laid, and in the generation after this thirtieth century the Great Pyramid of Gizeh was built. With amazingly accelerated development the Egyptian passed from the earliest example of stone masonry just before 3000 B.C. to the Great Pyramid just after 2900. The great-grandfathers built the first stone masonry wall a generation or so before 3000 B.C., and the great-grandsons erected the Great Pyramid of Gizeh, within a generation after 2900. It will be seen that this development falls chiefly in the century between 3000 and 2900 B.C., that is the thirtieth cen-

[1] Delivered before the National Academy of Sciences in Washington, D. C., April 28 and 29, 1910, as the seventh series of lectures on the William Ellery Hale Foundation.

FIG. 66. TERRACED TOMB STRUCTURE OF PHARAOH ZOSER AT SAKKARA, EGYPT. The oldest known superstructure of stone,—built by the architect Imhotep (30th century B.C.).

tury B.C., which for this reason occupies more space in the diagram than the thousand years which precede it. No century in the history of man, except the nineteenth century of our era, has witnessed as rapid an expansion of man's control of material forces as the thirtieth century B.C.

It is therefore of great interest to contemplate the most revolutionary monument of that revolutionary century, the earliest stone building in existence (Fig. 66). This monument marks definitely the transition from sun-dried brick to stone masonry. It was erected as the tomb of King Zoser of the Third Dynasty, by his chief physician and architect Imhotep. This great man, the first builder of monumental architecture in stone, is little known, his fame having been rather groundlessly shifted to King Solomon by our friends, the modern Free Masons. Nevertheless we should not forget that he was the first builder to put up a great superstructure of stone 200 feet high, which still survives as the earliest stone building in existence. Imhotep's fame as a physician has eclipsed his reputation as an architect. He became the Asclepias of the Greeks, the Æsculapius of the Romans, and thus passed into the great company of the ancient gods.

The vast cemetery buildings which followed Imhotep's introduction of stone masonry superstructures reveal to us the first great civilized age of human history, an age to which these structures have given their name, so that it is commonly called the Pyramid Age. It lasted nearly 500 years from a little after 3000 to a little after 2500 B.C. The monuments and cemetery buildings of Gizeh are the monumental expression of the capacity of the first great state in human history.

They suggest a vista never to be forgotten. Out along the desert margin (Fig. 67) is many a grave of the prehistoric Egyptian peasant. The low sand or gravel heap, which once marked it, is the lineal ancestor of the vast monuments of Gizeh, the most tremendous feat of engineering ever achieved by ancient man. What a development is here! Not merely a development in the mechanical arts, which beginning with the sand heap have at last achieved the pyramid, but also a development in the organization of government and society, which slowly advancing in the thousand years or more which lie between the sand heap and the pyramid, has gradually passed from the feeble initiative and limited powers of the individual to the elaborate capacities of a highly organized state, so efficient that it is able with unerring precision to concentrate all

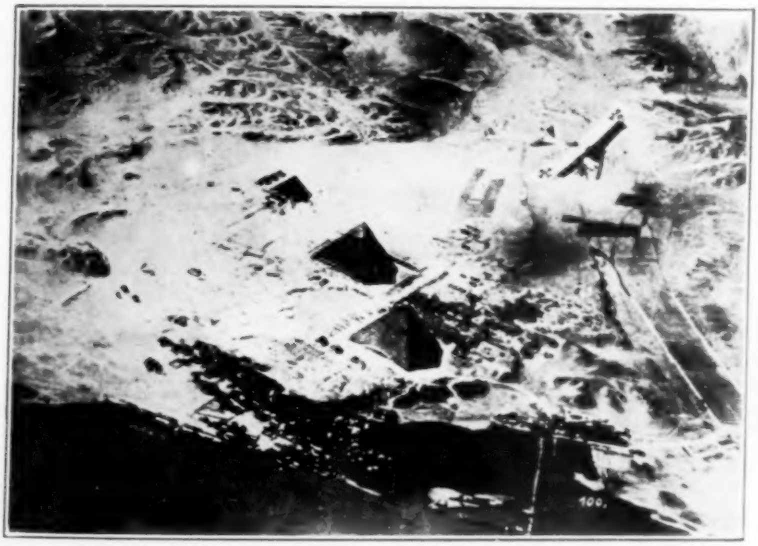


FIG. 67. THE CEMETERY OF GIZEH SEEN FROM AN AEROPLANE. These pyramids are the tombs of the kings and royal ladies of the Fourth Dynasty (about 2900 to 2750 B.C.). They are surrounded by the massive rectangular masonry tombs or "mastabas" of the nobles and officials of the same period. (Copyright by Moussault, N. Y.)

its vast resources of wealth and labor and mechanical skill upon one supreme achievement never later to be surpassed.

The Great Pyramid of Gizeh (Fig. 68) is the most impressive surviving witness to the final emergence of organized man from prehistoric chaos and local conflict, for it discloses him to us as he comes for the first time completely under the power of a far-reaching and comprehensive centralization effected by one all-controlling sovereign hand. Not the least remarkable aspect of this State is the sovereign's confidence in its efficiency. Here is a tomb containing 2,300,000 blocks of limestone, each weighing about two and a half tons, the assembling and erection of which in this building required the labor of one hundred

FIG. 68. THE GREAT PYRAMID OF GIZEH, THE TOMB OF THE PHARAOH KHUFU (CHEOPS), BUILT IN THE TWENTY-NINTH CENTURY B.C. It is the largest stone superstructure ever erected whether in ancient or (except recently) in modern times.

thousand men for some twenty years. Consider the daring imagination which could look out over this plateau, when it stood bare and empty, before its occupation by this building, and measuring off a square containing thirteen acres dared to begin covering it with a pile of stone masonry nearly 500 feet high. What must have been the mental quality of a man whose great-grandfathers had put together the first piece of stone masonry, and whose grandfathers had put up the first stone

superstructure—what must have been the mental quality of a ruler who dared to plan and undertake a tomb of such colossal proportions that no such structure ever later attempted has approached it in size or in quality of workmanship! Such considerations give us an impressive measure of the Pharaoh's confidence in the efficiency of his administrative machine.

He must likewise have had great confidence in the ability of his builders to meet the difficult problems which at once confronted them as they mounted the Gizeh plateau and began laying out the ground plan of the vast royal tomb which they were called upon to erect. One finds it difficult to imagine the feelings of these earliest architects, the great-grandsons of the men who had laid the first stone masonry, as they paced off the preliminary plan and found an elevation in the surface of the desert which prevented them from sighting diagonally from corner to corner and applying directly a well-known old Egyptian method of erecting an accurate perpendicular by means of measuring off a hypotenuse.

It is evident, however, that the Egyptian engineers early learned to carry a straight line over elevations of the earth's surface, or a plane around the bends of the Nile. In his endeavor to record the varying Nile levels in all latitudes the Egyptian engineer was confronted by nice problems in surveying even more exacting than those which he met in the Great Pyramid. A study of the surviving nilometers has disclosed the fact[25] that their zero points, always well below lowest water, are all in one plane. This plane inclines as does the flood slope, from south to north. The Pharaoh's engineers succeeded in carrying the line in the same sloping plane, around innumerable bends in the river for some seven hundred miles from the sea to the First Cataract. It is not surprising in view of the difficulty of the feat, accomplished as it necessarily was with primitive instruments about which we know nothing—it is not surprising under these circumstances, that although they kept their line in one plane, they did not succeed in establishing the slope of their line exactly parallel with the flood slope. Later, however, when they extended this line up river they succeeded in carrying it very closely parallel with the flood slope for some two hundred miles further southward to the Second Cataract.

The builders of the Great Pyramid were therefore already in possession of the methods which enabled the Pharaoh's engineers to lay out a seven-hundred mile line of nilometers in one plane. The sockets cut into the limestone surface of the desert

[25] L. Borchardt, "Nilmesser und Nilstandsmarken."

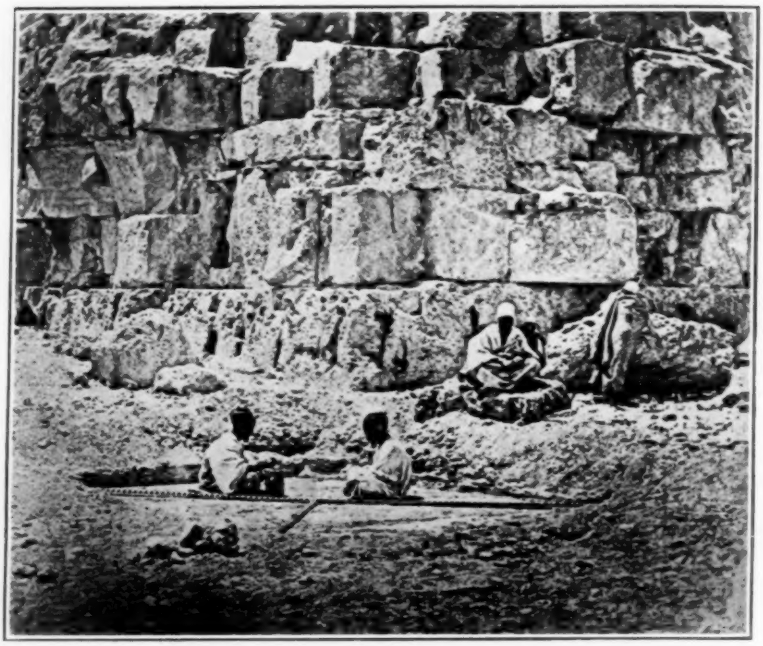


FIG. 69. RECTANGULAR SOCKET CUT IN THE NATIVE ROCK UNDERLYING THE GREAT PYRAMID. In this socket the northeast corner-stone of the building was laid; it was carried off by the Moslems.

plateau in which the cornerstones of the Great Pyramid were laid, still survive (Fig. 69), though the cornerstones themselves have been quarried out by Moslem vandals. These sockets enabled Petrie to establish the length of the sides as 755 feet. The maximum error he found to be .63 of an inch, that is less than one fourteen-thousandth of the total length of the side. The error of angle at the corners he found to be 12″ of a degree, that is one twenty-seven-thousandth of the right angle which the architect had laid out at the corner.

It is not a little interesting to follow the methods by which an agricultural people in a few generations developed the power to manipulate such vast masses of architectural materials as the Pharaoh's architects were then called upon to rear nearly 500 feet above this ground plan. The ruins of other pyramids and a pyramid left in an unfinished state at Gizeh have revealed much of the process of construction. Sun-dried brick ramps which were built higher as the pyramid rose, furnished an inclined plane up which the stone blocks were dragged by main strength on wooden sledges. Just how each block was shifted from the sledge to its particular place in the structure is still

uncertain; for the description of the device for this purpose left us by Herodotus is not clear. The indications now are that the pulley-block was already available, but it is unlikely that its ability to multiply power was understood. After the completion of the building the ramps were taken down (Fig. 70).

The most remarkable feat of engineering involved in the erection of the Great Pyramid is probably the construction chambers rising in a series over the sepulcher chamber (Fig. 71). We have here a series of five roofs, the lowest built of granite blocks about twenty-seven feet long, six feet high and over four feet thick. They weigh some fifty-four tons each. After being quarried at the First Cataract these heavy blocks were brought six hundred miles down the river, dragged up to the plateau and then up the brick ramps to a level perhaps two hundred feet above the pavement, where they were so laid that they might protect the burial chamber from being crushed in by the weight of more than two hundred vertical feet of masonry rising above it. The principle which the pyramid engineers seem to have had in mind, was a mistaken one. They seem to have thought that if the topmost granite roof gave way, it was a good thing to have another ready just below it. The series of granite roofs is therefore of purely contingent value. They are crowned however, by a wiser construction of enormous limestone beams, an arch in principle but in appearance a peak roof. These vast

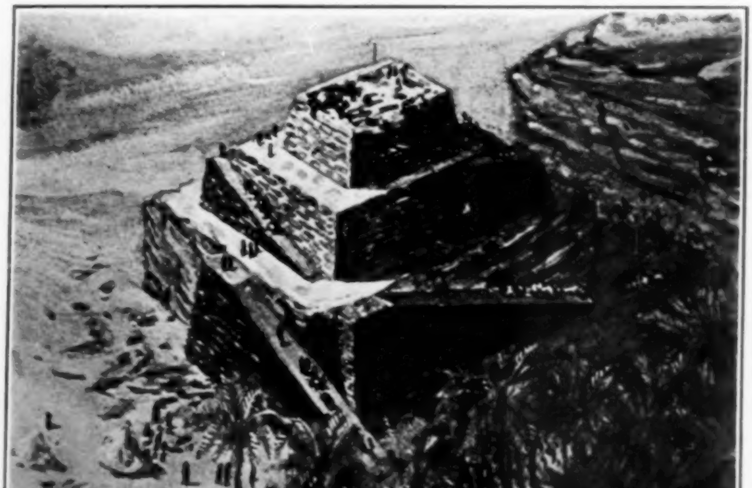


FIG. 70. UNFINISHED PYRAMID AT GIZEH, SHOWING SUN-DRIED BRICK RAMPS FOR CARRYING UP BUILDING MATERIAL. (Restored after Hoelscher.)

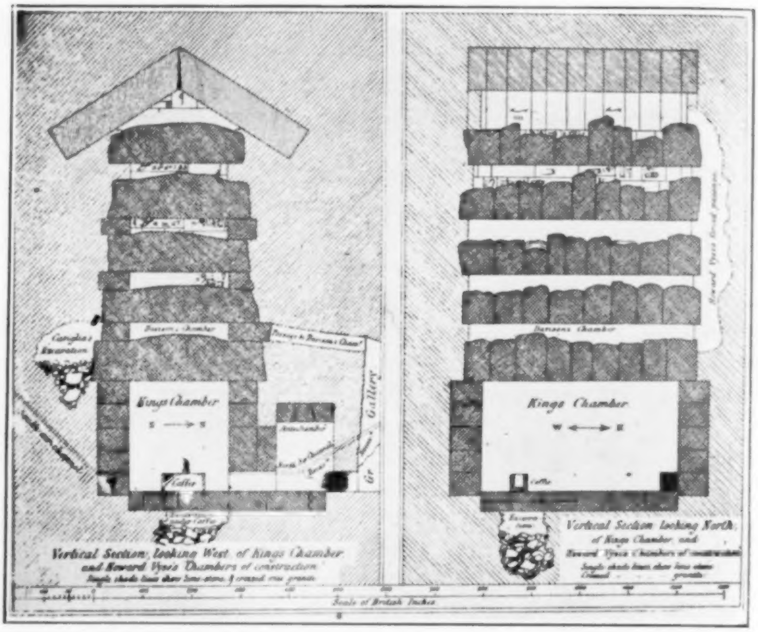


FIG. 71. SEPULCHRE CHAMBER IN THE GREAT PYRAMID OF GIZEH. Showing five precautionary construction chambers above it intended to carry the vast burden of the overlying masonry.

beams of limestone receive the colossal burden on their peak, and by their sideward thrust transfer it to the core masonry of the pyramid on each side of the sepulcher chamber, and thus save the roof of the latter from being crushed in. The effectiveness of the structure is strikingly brought out by the fact that although the beams of the horizontal granite roof immediately over the burial chamber have been broken short off entirely across the chamber by an ancient earthquake, nevertheless the contiguous ends of the beams on each side of the fracture have hardly settled perceptibly.

The ponderous mechanics of which the pyramid engineers were master is impressively illustrated by the enormous mass of stone chips produced by the army of stone-cutters who wrought 2,300,000 two-and-a-half ton blocks of limestone for the pyramid masonry. The accumulation of this rubbish had to be disposed of, and the foremen had it carried to the edge of the plateau and shot over the face of the cliff where it still lies at the angle of rest. It is equal in bulk to about half of the mass of the pyramid itself.[26]

[26] The best survey of the Great Pyramid has been furnished by Petrie, "The Pyramids and Temples of Gizeh," to which the above discussion is much indebted.

The industrial ability of the Nile-dwellers, which we found advancing so rapidly in the Early Dynasties, had in no way lagged behind the extraordinary engineering capacity which we have just been noticing. The skilful craftsmanship displayed in the cutting of the blocks for the Great Pyramid was certainly not to be expected from men whose great-grandfathers had laid the first stone masonry. The rough core masonry forming the present exterior of the building (Fig. 68) was originally sheathed in a magnificent cuirass of casing masonry extending from summit to base. Only a few blocks of this casing still survive along the base on the north side of the pyramid (Fig. 72). They were quarried away as building material by the Moslem builders of Cairo, especially from the fourteenth century A.D. In such finished masonry Petrie found joints displaying a contact of one five-hundredth of an inch, and joints of this kind are sometimes ten or twelve feet long. As Petrie has well said, we find here an accuracy like that of the manufacturing optician applied on a scale of acres.

The sovereign control of refractory materials by these consummate craftsmen at the beginning of the Pyramid Age is well illustrated by the new means of drilling which they had devised and the skill with which they applied it. The crank-drill of the Early Dynasties (Fig. 56) with a cutting edge of stone, which

FIG. 72. BLOCKS OF CASING MASONRY OF THE LOWEST COURSE STILL IN POSITION ON THE NORTH SIDE OF THE GREAT PYRAMID. (Photograph by L. Dow Covington.)

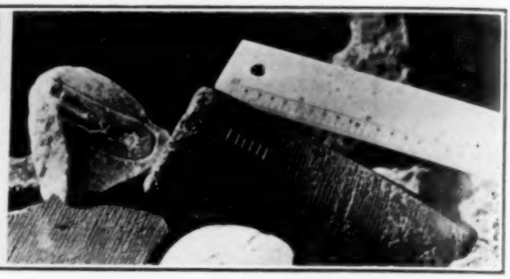


FIG. 73. UNFINISHED GRANITE VASE WITH THE BOTTOM OF THE CORE LEFT BY THE TUBULAR DRILL VISIBLE AT THE BASE OF THE BORE. (In the Field Museum of Natural History, Chicago.)

FIG. 74. CORE BROKEN OUT OF A HOLE MADE BY A TUBULAR DRILL AS SHOWN IN THE PRECEDING FIGURE. (From a photograph by Petrie.)

involved cutting out the entire mass of material included within its cylindrical bore, had been superseded by a tubular drill, presumably of copper reinforced by some cutting powder. It economized labor by boring around an interior core, which could later be broken away with a single blow (Figs. 73 and 74). This hollow tubular drill is a device which has been reinvented in our own time. The highly developed industries growing out of this ingenuity and skill in craftsmanship are elaborately displayed in colored relief sculptures in the masonry tombs of the nobles of the period at Gizeh (Fig. 67) and elsewhere in the great cemeteries of the Pyramid Age. Perhaps nothing better exemplifies the attainments which made Egypt the mother of arts than the sumptuous work of the lapidary and goldsmith (Fig. 75), which was already on its way to reach a supreme level of attainment never surpassed and rarely equaled in modern times.

The pyramid cemeteries likewise reveal to us the remarkable progress of this earliest highly cultivated age in architecture. In the development of fundamental architectural

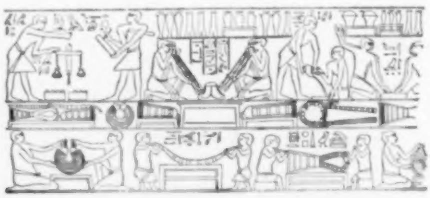


FIG. 75. GOLDSMITH'S WORKSHOP IN THE PYRAMID AGE. *Upper row:* At left chief goldsmith weighs out costly stones and a scribe records the weights; next six men with blow-pipes are blowing a fire in a small clay furnace; next a workman pours out paste; at right end four men are beating gold leaf. *Middle row:* Pieces of finished jewelry. *Lower row:* Workmen seated at low benches are putting together and engraving pieces of jewelry. Several of these men are dwarfs.

forms the so-called Second Pyramid of Gizeh (Fig. 76), built by Khafre (Greek *Chefren*, Fig. 77), displays some remarkable advances, especially in the buildings connected with it. The unprecedented exaltation of the Pharaoh's power and station was converting his tomb into a great architectural complex where the ancient and originally simple practices for the maintenance of the dead were carried on with a sumptuous magnificence which required a fitting architectural setting. The food, drink and clothing once regularly presented to the dead by merely

FIG. 76. SECOND PYRAMID OF GIZEH, BUILT BY KING KHAFRE IN THE 29TH CENTURY B.C. A bonnet of casing masonry is still preserved at the summit; below on the left we discern the ruins of the pyramid-temple described in the text and shown in Fig. 79. (By Underwood & Underwood, Copyright.)

setting it down before the simple tomb, now required a large and splendid building erected on the east side of the pyramid facing the royal city in the valley below. This building had thus become a mortuary temple, which we call a pyramid temple. Here ministered an endowed priesthood whose sole duty it was to maintain the offerings for the royal dead in the temple. They lived in the royal city below, and a long gallery, built of stone masonry a quarter of a mile in length, furnished them a convenient corridor, by means of which they could reach the temple above (Fig. 78). Giving access to this long cor-

FIG. 77. DIORITE PORTRAIT OF KING KHAFRE, BUILDER OF THE SECOND PYRAMID OF GIZEH (29TH CENTURY B.C.)

ridor there was at the lower or townward end, a monumental portal building, which seems to have served also as an additional and more conveniently accessible mortuary temple. It has therefore been appropriately termed by Reisner the "valley temple." All these parts making up the new and extensive pyramid complex may be easily recognized in Fig. 78.

In the development and design of these accessory structures the pyramid builders were confronted by fundamental problems

of monumental architecture, in the solution of which they made great advances. Chief among these problems was that of carrying the roof over the void, and likewise the lighting of a hall with very thick side walls. To carry the roof over the void the Gizeh architects introduced into the hall a series of massive rectangular piers, each pier a monolithic block of polished granite (Fig. 80), brought from the First Cataract. The problem of lighting such a hall was met by raising higher than the roof on either side a middle section of the roof symmetrically placed along the axis of the building. The difference in level between this higher central portion of the roof and the lower portions on each side was occupied by light chutes, which furnished light to the hall through the roof (Fig. 79). The pyramid architects had thus produced an incipient nave roofed by a clerestory, with openings for light which were the ancestors of clerestory windows, and the fundamental elements of the basilica and its child the Christian basilica cathedral were therefore devised by the early Egyptian builders of the twenty-ninth century B.C.

Within three generations and not much more than a century after the erection of Khafre's splendid hall at Gizeh, the royal architects of Egypt were looking back upon the Gizeh buildings as crude and archaic. At Abusir, a few miles up the margin of the desert south of Gizeh, they were erecting for the Pharaohs of the Fifth Dynasty (2750 to 2625 B.C.) a wonderful

FIG. 78. RESTORATION OF THE GIZEH CEMETERY. (After Hoelscher.) The Great Pyramid of Khufu (Cheops) is on the right, from the summit of which the view in Fig 76 was taken; and the Second Pyramid of Khafre is on the left, with its temple and causeway or covered corridor connecting the temple above with the royal city below. Beside the "valley temple" giving access to the corridor is the Great Sphinx, a portrait of Khafre.

FIG. 79. INCIPIENT CLERESTORY IN THE HALL OF THE VALLEY TEMPLE OF KHAFRE AT GIZEH BUILT IN THE 29TH CENTURY B.C. The narrow light-chutes occupying the difference in level between a higher roof over the nave and a lower roof beside it are the lineal ancestors of the clerestory windows of European architecture. The oblique light which they admit is seen in Fig. 80.

series of tombs (Fig. 81) displaying remarkable progress in architecture. The Abusir pyramids themselves were to be sure much smaller and less imposing than those of Gizeh, but the pyramid temples at Abusir gave the Fifth Dynasty architects opportunities not presented by the pyramid form which was a matter already settled. In place of the bare rectangular Gizeh piers of a century earlier the Abusir architects designed a series of supports (Fig. 82) each representing a conventionalized palm tree, the trunk of which formed the shaft of a column, the capital being the graceful crown of foliage surmounting the whole. Thus emerged at the hands of Egyptian architects in the middle of the twenty-eighth century B.C. the earliest known columns and the first colonnades (Fig. 83).

These earliest colonnades are notable not only as such, but also because they are the earliest outstanding examples of the Egyptian use of decorative motives taken from the vegetable

world. It showed the way for the development of the rich fund of decorative beauty which the architects and artists of western Asia and Europe, following Egypt, afterward discovered in vegetable forms, as they brought forth such things as the Corinthian column or the sumptuous carving of the Gothic cathedrals. Moving along the same line the Abusir architects also devised charming columns by the use of the lotus and papyrus, of which the latter became very common.

It is impossible within the limits of this brief sketch to discuss the social and governmental development which went on parallel with the amazingly rapid mechanical, industrial, artistic and architectural advance at which we have been glancing.

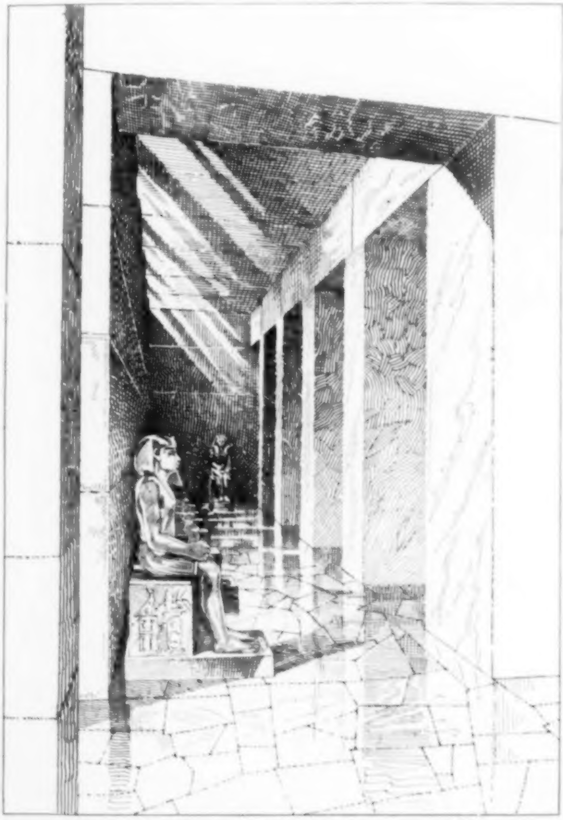


FIG. 80. RESTORATION OF CLERESTORY HALL IN THE VALLEY TEMPLE OF KHAFRE AT GIZEH. (After Hoelscher.) This is the hall seen beside the Great Sphinx at the foot of the long corridor in Fig. 78. A double row of the rectangular piers seen here supports a roof higher than that on either side of it and thus forms a real nave. The oblique light comes through the light-chutes, or incipient clerestory windows, as shown in Fig. 79.

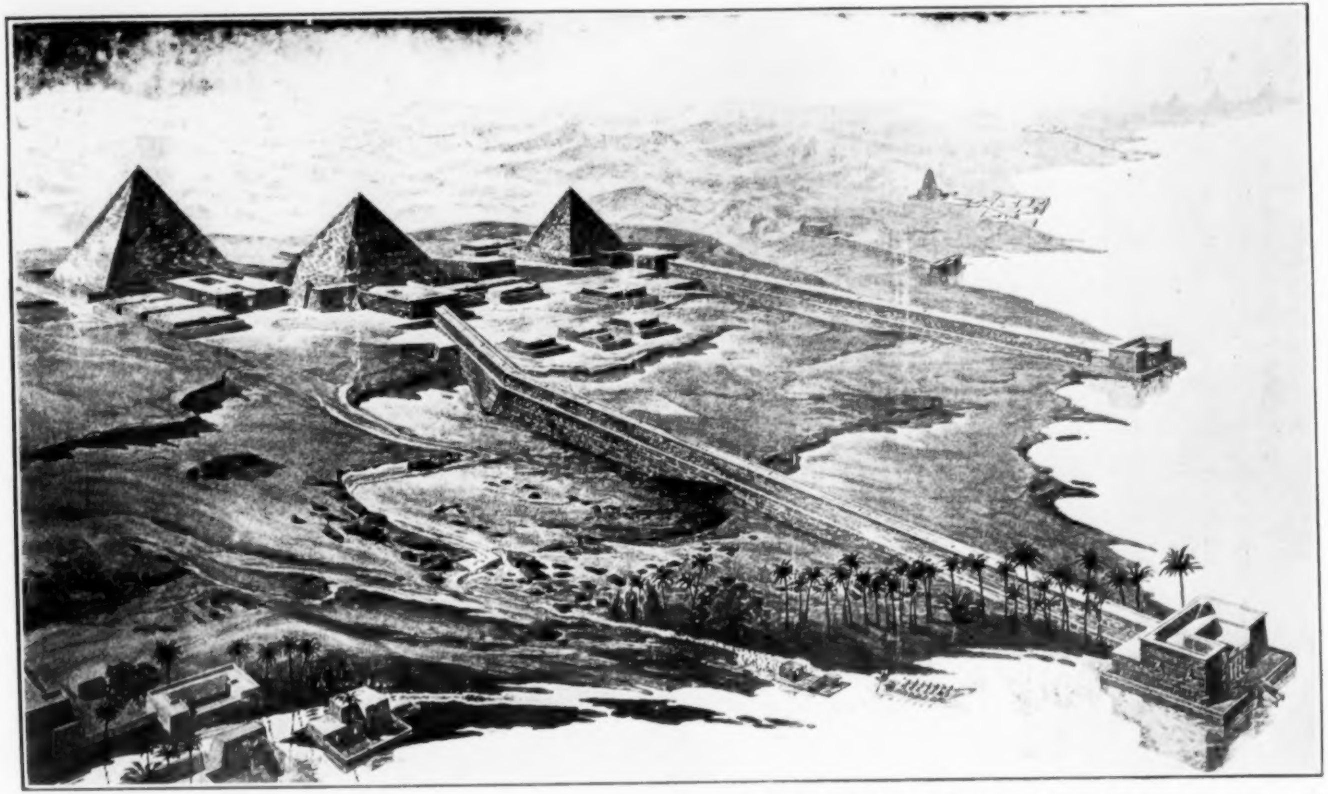


Fig. 81. Restoration of the Pyramid Cemetery of the Fifth Dynasty at Abusir built in the 28th and 27th centuries B.C. (After Borchardt.) The pyramid of Sahure, built not long after 2750 B.C., with its corridor and temples is seen in the background. Here were found the colonnades and the sea-going ships shown in Figs. 82–84

As we recall the Nile valley of the Pleistocene Age, we are conscious of the marvelous transition through which it has passed. We of America are especially fitted to visualize and to understand the wonderful transformation of a wilderness into a land of splendid cities. But the men whose powers of achievement planted great and prosperous cities along the once lonely trails of our own broad land, received art, architecture, industry, commerce and social and governmental traditions as an inheritance from earlier times. There was an age, however, when the development from barbarism to civilization with all its impressive outward manifestations in art and architecture had to be accomplished *for the first time*. That happened along the Nile, and it seems therefore like a magical transition, as we see the trail of the Stone Age hunter leading up from the river through the jungle marsh, transformed into an avenue of sculptured sphinxes and tall obelisks; while in the background where once the trail terminated at the hunter's group of wattle huts peeping through the reeds, there rises a stately city adorned with imposing temples and monuments of stone.

The prehistoric hunter whose self-expression was quite content to ply the flint graving tool in carving symmetrical lines of game beasts along the ivory handle of a flint dagger has been transformed by fifty generations of social evolution into a royal architect, able to transmute his visions of a great state into architectural forms of dignity and splendor, launching great bodies of organized craftsmen upon the quarries of the Nile cliffs, and summoning thence stately and rhythmic colonnades, imposing temples and a vast rampart of pyramids, the greatest tombs ever erected by the hand of man. We must regard these things, therefore, as the outward and monumental expression of man's social and governmental advance, with which we must also remember his unfolding inner life had kept even pace. The quickened imagination which finds expression in noble architectural forms is to a large extent a product of social development, of an imposing vision of the kingship and of the state, as well as of the exalted station of the gods who guide the state. These were new forces unknown to the life of the primitive hunters who elsewhere outside of the Egypto-Babylonian group, still continued to live by the chase throughout most of the world, or had here and there, within reach of influences from the Egypto-Babylonian group, made a beginning in agriculture and cattle-breeding.

In view of the tiny city-kingdoms, disunited and fighting among themselves, which at this time were the only organized

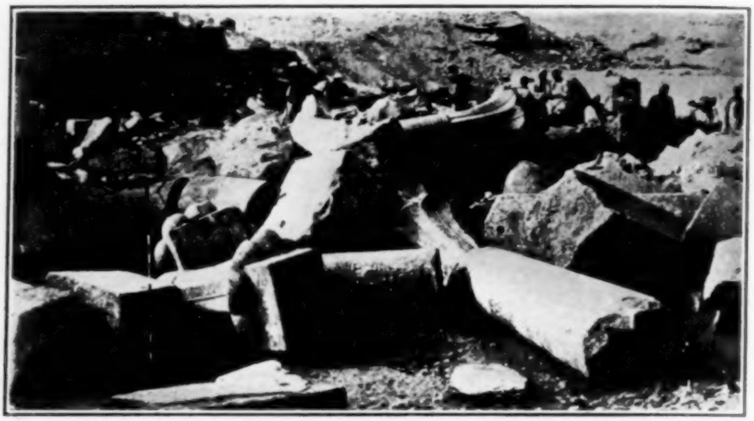


FIG. 82. MONOLITHIC GRANITE COLUMNS AS FOUND BY BORCHARDT IN THE TEMPLE OF SAHURE AT ABUSIR. (Compare Fig. 81.)

states in Babylonia, it is evident that the first great civilized nation of highly cultivated life had come into being on the Nile. Such a fabric of civilized life developed by a great community of several million souls could not exist for five hundred years without exerting a profound influence in the adjacent Mediterranean upon which it looked out and likewise in neighboring Asia which began at the eastern delta gates. The evidences for early Egyptian influences moving across the Mediterranean

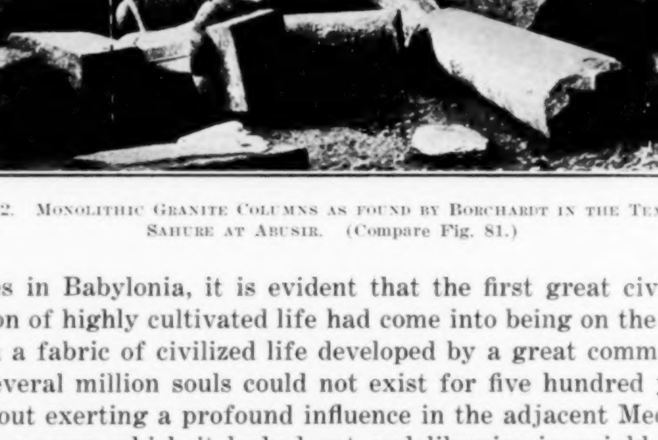


FIG. 83. RESTORATION OF THE COLONNADED COURT OF THE PYRAMID TEMPLE OF SAHURE. (After Borchardt.) From the columns found as shown in Fig. 82 it was not difficult to restore the court as it was left by the architects. This court is the oldest colonnaded structure now known in the history of architecture, having been erected not long after the middle of the 28th century B.C. It is evidently the ancestor of the colonnaded courts of Hellenistic Europe as shown in Fig. 123.

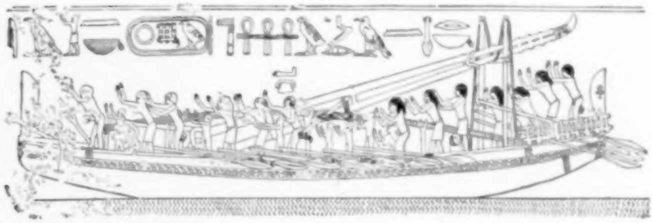


FIG. 84. EARLIEST REPRESENTATION OF A SEA-GOING SHIP, FOUND AMONG THE WALL RELIEFS IN THE PYRAMID TEMPLE OF SAHURE. (After Borchardt.) The Pharaohs of the Third Dynasty in the 30th century B.C. were already carrying on commerce in the Mediterranean with such ships as this, although this relief scene was sculptured in the middle of the 28th century. Such vessels represent the beginning of salt sea navigation.

and entering Stone Age Europe are now obvious enough. From a study of the archaic remains of Crete Sir Arthur Evans observes: "The possibility of some actual immigration into the island of the older Egyptian element . . . can not be excluded."[27] The excavation of the Abusir pyramids and temples has revealed the ships which carried these Egyptian influences across the eastern Mediterranean (Fig. 84). These are the earliest known sailing ships and the earliest sea-going craft of which we know the form and rig. When the Mediterranean peoples, like the Phœnicians, afterward likewise took to the sea, their ships (Fig. 116) were reproductions of these Egyptian vessels. It is therefore evident that the Egyptian sailing ships which crossed the Mediterranean at the beginning of the Pyramid Age as early as the thirtieth century B.C. were not only the first sea-going ships devised by man, but were likewise the ancestors of all salt-water craft of the early world, and hence of the modern world also. The native shipping of East Indian waters to this day exhibits details and characteristics which are of unmistakable ancient Egyptian origin.

(To be continued.)

[27] "New Archæological Lights on the Origins of Civilization in Europe," presidential address before the British Association, 1916, reprinted Annual Rep. Smithsonian Inst., 1917, p. 441.

THE PROGRESS OF SCIENCE

THE ST. LOUIS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE American Association for the Advancement of Science will hold its seventy-second stated meeting at St. Louis during the week beginning on Monday, December 29. It will be the eighteenth of the convocation-week meetings of the national scientific societies. Meetings of the council, and all sessions of the association and of the affiliated societies will be held in the Soldan High School. Hotel Statler will be the general headquarters. The local executive committee consists of George T. Moore, Alexander S. Langsdorf, Augustus G. Pohlman, John W. Withers and John M. Wulfing.

The opening general session of the association will be held on Monday night, in the Assembly Room of the Soldan High School. Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, will preside. General announcements concerning the meeting will be made, the revised constitution of the associaion will be presented for vote and the retiring president, Professor John Merle Coulter, of the University of Chicago, will deliver his address on "The Evolution of Botanical Research." The meeting will be followed by an informal reception to members of the American Association and of affiliated societies.

THE SOLDEN HIGH SCHOOL.
Headquarters for the St. Louis Meeting of the American Association for the Advancement of Science.

MAIN ENTRANCE OF THE MISSOURI BOTANICAL GARDEN FROM THE INTERIOR.

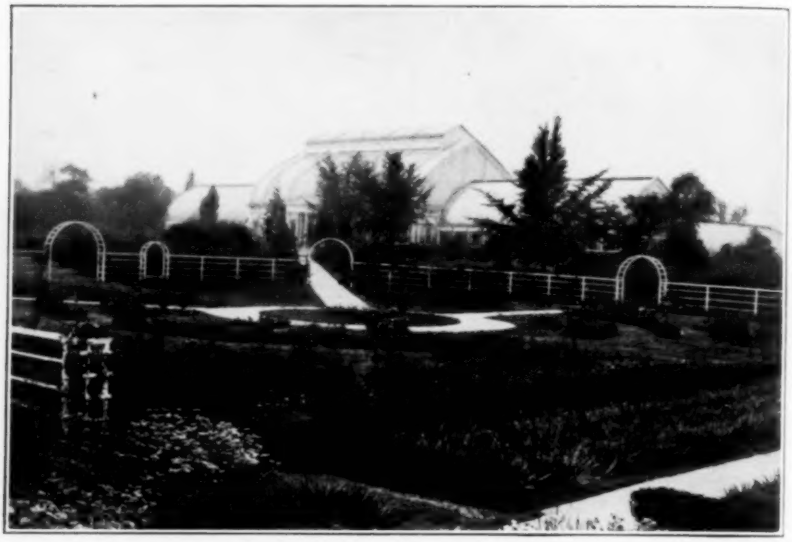
The addresses of the retiring vice-presidents of the sections, to be delivered throughout the week are as follows:

Section A.—George D. Birkhoff. "Recent advances in dynamics."
Section B.—Gordon F. Hull. "Some aspects of physics in war and peace."
Section C.—Alexander Smith. "Chemistry as it is taught."
Section D.—Ira N. Hollis. "Industrial problems of the United States."
Section E.—David White. "Geology as taught in the United States."
Section F.—William Patten. "The message of the biologist."
Section G.—Albert F. Blakeslee. "Sexuality in the mucors."
Section H.—Aleš Hrdlička. "The relations of psychology and anthropology."
Section I.—John Barrett. "New after-the-war phases of practical Pan-Americanism."
Section K.—F. S. Lee. "The untilled fields of public health."
Section L.—Stuart A. Courtis. "The part played by heredity and maturity as factors conditioning the effects of training."
Section M.—Henry P. Armsby. "The organization of research."

On Tuesday night, December 30, Dr. Simon Flexner, president of the association, will deliver a popular lecture, complimentary to the members of the association and affiliated societies and to the general public.

The American Association has met twice before in St. Louis, in 1878 and 1903, the latter being the second of the convocation-week meetings following the inauguration of the plan the year before at Washington. During the forty-one years that have elapsed since the first St. Louis meeting, there has been a westward movement of scientific institutions and scientific men, so that the center of our scientific population is tending to approach the general center of population which is now in Indiana, but which is moving in the direction of St. Louis.

The educational and scientific institutions of the city—exceeded in size only by New York, Philadelphia and Chicago—are commensurate with its commercial position. Washington University with its



MAIN CONSERVATORIES OF THE MISSOURI BOTANICAL GARDEN LOOKING ACROSS THE ROSE GARDEN.

great medical school has long been one of the strongest non-state-supported institutions west of the Atlantic seaboard, and has guarantees for future development. St. Louis University is a leading Catholic institution. The public-school system has maintained the position given to it on the days when William T. Harris was superintendent. An Academy of Science was organized in 1856. The Missouri Botanical Garden, established by Henry Shaw, is one of our chief centers for research in botany. The St. Louis Exposition of 1904 and its International Congress of Arts and Sciences gave the city a historical position in scientific cooperation among the nations.

NATIONAL SCIENTIFIC SOCIETIES MEETING AT ST. LOUIS

THE American Association has established a general convocation-week meetings once in four years, held successively in Washington, Chicago and New York. One of these meetings will occur next year in Chicago, and it is hoped that at that time all the national scientific societies will join together in a meeting that will give impressive evidence of the members and influence of scientific men. In the intervening years many of the scientific societies prefer to hold separate meetings. Thus this year the geologists, psychologists and anthropologists meet in Boston, the American Society of Naturalists at Princeton, the Federation of Biological Societies, which had planned to meet in Toronto has been compelled unexpectedly to change to Cincinnati, the American Association of University Professors will meet with the political science and historical associations in Cleveland. The list of national scientific societies meeting at St. Louis is so long that we can only record their names and their officers, which are as follows:

Mathematical Association of America.—(Missouri Section.) December 29. President, H. E. Slaught; Secretary, Professor Paul R. Rider, Washington University, St. Louis, Mo.

American Mathematical Society.—(Chicago and Southwestern Sections.) December 30 and 31. Joint session with Section A on December 30. Acting Secretary, Dr. Arnold Dresden, 2114 Vilas St., Madison, Wis.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Secretary, Dr. William A. Hedrick, Central High School, Washington, D. C.

American Meteorological Society.—December 29 to 31; joint meetings with Sections B and E on dates to be announced. Secretary, Dr. Charles F. Brooks, U. S. Weather Bureau, Washington, D. C.

American Physical Society.—December 30 to January 1, in joint session with Section B, President, J. S. Ames. Secretary, Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio.

Society for the Promotion of Engineering Education.—President, Arthur M. Greene, Jr. Secretary, Professor Frederic L. Bishop, University of Pittsburgh, Pittsburgh, Pa.

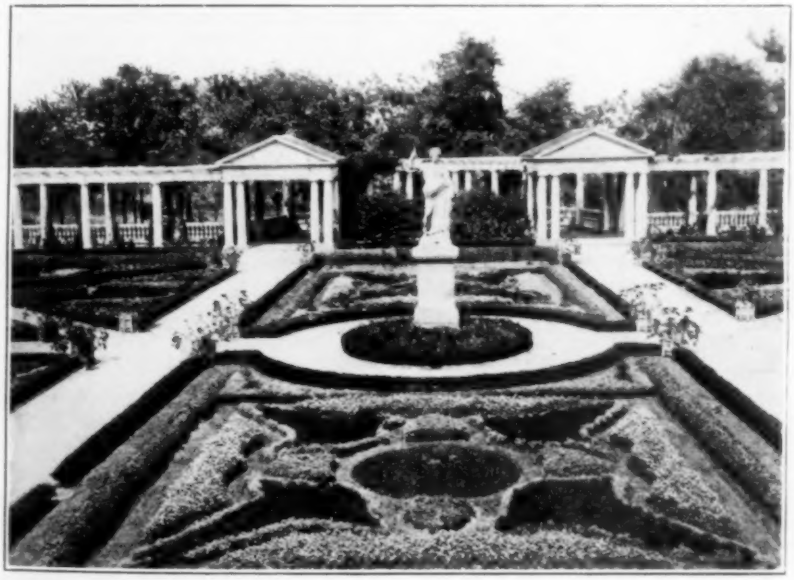
Optical Society of America.—January 2. President, F. E. Wright. Secretary, Dr. P. G. Nutting, Westinghouse Research Laboratory, East Pittsburgh, Pa.

Association of American Geographers.—December 30 to January 1. President and Acting Secretary, Dr. Charles R. Dryer, Oak Knoll, Fort Wayne, Ind.

National Council of Geography Teachers.—December 29 and 30. President, Albert P. Brigham. Secretary, Professor George J. Miller, State Normal School, Mankato, Minn.

American Society of Zoologists.—December 29 to 31, in joint session with Section F. Joint session with Ecological Society of America on Tuesday afternoon, December 30. Zoologists' dinner, with address of Vice-president of Section F and moving picture films of Barbadoes-Antigua Expedition by C. C. Nutting, on Wednesday night, December 31. President, C. M. Child. Secretary, Dr. W. C. Allee, Lake Forest College, Lake Forest, Ill.

Entomological Society of Amer-



CENTRAL PANEL OF THE ITALIAN GARDEN.

ica.—December 29 and 30. President, J. G. Needham. Secretary, Dr. J. M. Aldrich, U. S. National Museum, Washington, D. C.

American Association of Economic Entomologists.—December 31 to January 2. President, W. C. O'Kane. Secretary, Albert F. Burgess, Gipsy Moth Parasite Laboratory, Melrose Highlands, Mass.

Botanical Society of America.—December 30 to January 1, with joint sessions as follows: Tuesday, December 30, Section G; Wednesday, December 31, American Society for Horticultural Science; Thursday, January 1, 10 A.M., Ecological Society of America, 2 P.M., American Phytopathological Society. On Wednesday night, December 31, will be the annual dinner for all botanists, followed by presidential address. President, J. C. Arthur. Secretary, Professor J. R. Schramm, N. Y. State College of Agriculture, Ithaca, N. Y.

American Phytopathological Society.—President, C. L. Shear. Secretary, Dr. G. R. Lyman, U. S. Department of Agriculture, Washington, D. C.

American Society for Horticultural Science.—December 29 to 31. President, J. W. Crow. Secretary, Professor C. P. Close, College Park, Md.

Association of Official Seed Analysts.—Will meet on Monday and Tuesday, December 29 and 30. President, H. D. Hughes. Secretary, R. C. Dahlberg, University Farm, St. Paul, Minn.

Ecological Society of America.—December 30 to January 1, with joint session with the American Society of Zoologists on Tuesday, December 30, and with Botanical Society of America on Thursday, January 1. President, Barrington Moore. Secretary, Dr. Forrest Shreve, Desert Botanical Laboratory, Tuscon, Arizona.

American Pomological Society.—December 30 to January 1. President, L. H. Bailey. Secretary, Professor Edward R. Lake, Hotel St. Nicholas, Albany, Ga.

American Microscopical Society.—December 30, for luncheon and executive committee and on Wednesday, December 31, for business meeting just following Section F afternoon session. President, L. E. Griffin. Secretary, Professor Paul S. Welch, University of Michigan, Ann Arbor, Mich.

American Nature-Study Society.—December 30. President, L. H. Bailey. Secretary, Dr. Anna Botsford Comstock, Cornell University, Ithaca, N. Y.

Wilson Ornithological Club.—December 29 and 30. President, Myron H. Swenk. Secretary, Professor Albert F. Gainer, 924 Broadway, Nashville, Tenn.

American Metric Association.—December 29 and 30. President, George F. Kunz. Secretary, Howard Richards, Jr., 156 5th Avenue, New York, N. Y.

Society for the Promotion of Agricultural Science.—Secretary, Dr. C. P. Gillette, Colorado Agricultural College, Fort Collins, Colo.

Society of Sigma Xi.—President, Julius Stieglitz. Secretary, Dr. Henry Baldwin Ward, University of Illinois, Urbana, Ill.

Gamma Alpha Graduate Scientific Fraternity.—President, Norman E. Gilbert. Secretary, Dr. Albert H. Wright, Cornell University, Ithaca, N. Y.

Phi Kappa Phi.—December 31. President, Edwin E. Sparks. Secretary, Dr. L. H. Pammel, Iowa State College, Ames, Iowa.

Gamma Sigma Delta.—Thursday, January 1. President, C. H. Eckles. Secretary, Dr. L. H. Pammel, Iowa State College, Ames, Iowa.

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

ANNOUNCEMENT is made that Mr. John D. Rockefeller has added $10,000,000 to his previous endowment of the Rockefeller Institute for Medical Research. This gift, the largest made by Mr. Rockefeller at one time to the institution, is to meet rapidly growing needs in its many lines of research and in making new knowledge available in the protection of the public health and in the improved treatment of disease and injury.

By this increase in the endowment, new lines of research will be

sustained in biology, chemistry and physics, upon which medical science so largely rests, as well as in medicine itself, as will the study of many practical problems directly relating to diseases in men and animals which are already under way.

The local activities of the Rockefeller Institute in New York are chiefly carried on in the great laboratories and the hospital, which stand high on the bluff facing the East River, between East 64th and 67th Streets, a part of the old Schermerhorn Farm of an earlier day.

Near Princeton, N. J., the institute has a large farm, where it maintains a department of animal pathology. The laboratories and various accessory buildings here are devoted to research on the diseases of animals and effective methods for their prevention and cure, as well as to the study of the bearing of animal diseases upon the health and economic interests of man.

The scientific staff of the Rockefeller Institute numbers sixty-five, most of them highly trained and of large experience in the subjects to which they are exclusively devoted. The institute further employs 310 persons in its technical and general service. It is to the perpetual maintenance of such a group of men and women, with adequate facilities and suitable conditions for their successful work, for the general welfare, that the gifts of Mr. Rockefeller to the institute are devoted.

The scientific staff consists of members, associate members, associates and assistants. The members are:

Simon Flexner, pathology and bacteriology; director of the Laboratories.

Rufus Cole, medicine; director of the Hospital; physician to the Hospital.

Theobald Smith, director of the department of animal pathology.

Alexis Carrel, experimental surgery.

P. A. Levene, chemistry.

Jacques Loeb, experimental biology.

S. J. Meltzer, physiology and pharmacology.

Hideyo Noguchi, pathology and bacteriology.

PROBLEMS OF FOOD AND NUTRITION

THE National Research Council has formed a special committee on Food and Nutrition Problems, composed of a group of the most eminent physiological chemists and nutrition experts of the country. The members are: Carl Alsberg, chief, bureau of chemistry, Department of Agriculture; H. P. Armsby, director of the institute of animal nutrition, Pennsylvania State College; Isabel Bevier, director of department of home economics, University of Illinois; E. B. Forbes, chief, department of nutrition, Ohio Agricultural Experiment Station; W. H. Jordan, director, N. Y. Agricultural Experiment Station; Graham Lusk, professor of physiology, Cornell University Medical College; C. F. Langworthy, chief of office of home economics, Department of Agriculture; E. V. McCollum, professor of biochemistry, School of Public Health and Hygiene, Johns Hopkins University; L. B. Mendel, professor of physiological chemistry, Yale University; J. R. Murlin, professor of physiology and director of the department of vital economics, University of Rochester; R. A. Pearson, president of the Iowa State Agricultural College; H. C. Sherman, professor of food chemistry, Columbia University; A. E. Taylor, Rush professor of physiological chemistry, University of Pennsylvania; and A. F. Woods, botanist, president of Maryland State College of Agriculture.

This committee will devote its attention and activities to the solution

of important problems connected with the nutritional values and most effective grouping and preparation of foods, both for human and animal use. Special attention will be given to national food conditions and to comprehensive problems involving the coordinated services of numerous investigators and laboratories. The committee, with the support of the council, is arranging to obtain funds for the support of its researches, and will get under way, just as soon as possible, certain specific investigations already formulated by individual committee members and subcommittees. These include studies of the comparative food values of meat and milk and of the conditions of production of these foods in the United States, together with the whole problem of animal nutrition; the food conditions in hospitals, asylums and similar institutions; the nutritional standards of infancy and adolescence; the formation of a national institute of nutrition; and other problems of similarly large and nationally important character.

SCIENTIFIC ITEMS

We record with regret the death of Louis Valentine Pirsson, professor of geology in the Yale University, and of Allan McLane Hamilton, at one time professor of mental diseases in the Cornell Medical College.

The Nobel prize for physics for 1918 has been awarded to Professor Max Planck, of Berlin, and for 1919 to Professor Stark, of Greifswald. The prize for chemistry for 1918 has been awarded to Professor Fritz Haber, of Berlin.—The National Academy of Sciences has awarded its medal for eminence in the application of science to the public welfare to Mr. Herbert C. Hoover for his applications of science in the conservation, selection and distribution of food.

Dr. David P. Barrows, professor of education and later of political science in the University of California, at one time director of education for the Philippine Islands and author of works on the islands, has been elected president of the University of California, to succeed Dr. Benjamin Ide Wheeler.—Dr. Frank Schlesinger, director of the Allegheny Observatory of the University of Pittsburgh, has been elected director of the Yale Observatory.—Dr. Richard M. Pearce, professor of research medicine in the University of Pennsylvania under the John Herr Musser Foundation, has accepted the position of director of the newly established division of medical education of the Rockefeller Foundation. Dr. Pearce has sailed for Europe to carry out work in the interest of the foundation.

With the exception of approximately $25,000,000 the will of Henry C. Frick leaves his estate, believed to be worth approximately $145,000,000, for public, charitable and educational purposes. Mr. Frick's house and art collection in New York City, which after the termination of Mrs. Frick's life estate are to go the public, are valued at approximately $50,000,000. An endowment of $15,000,000 is provided to maintain this as "The Frick Collection." Pittsburgh, where much of Mr. Frick's wealth was acquired, receives a tract of about 151 acres of land in the 14th ward of that city for a park and $2,000,000 in trust to maintain and improve the property. The residuary estate to be divided into 100 shares valued at about $500,000 each, is left in nineteen institutions. Princeton University receives thirty of these shares, Harvard University, The Massachusetts Institute of Technology, and the Educational Fund Commission Pittsburgh, each receives ten shares.